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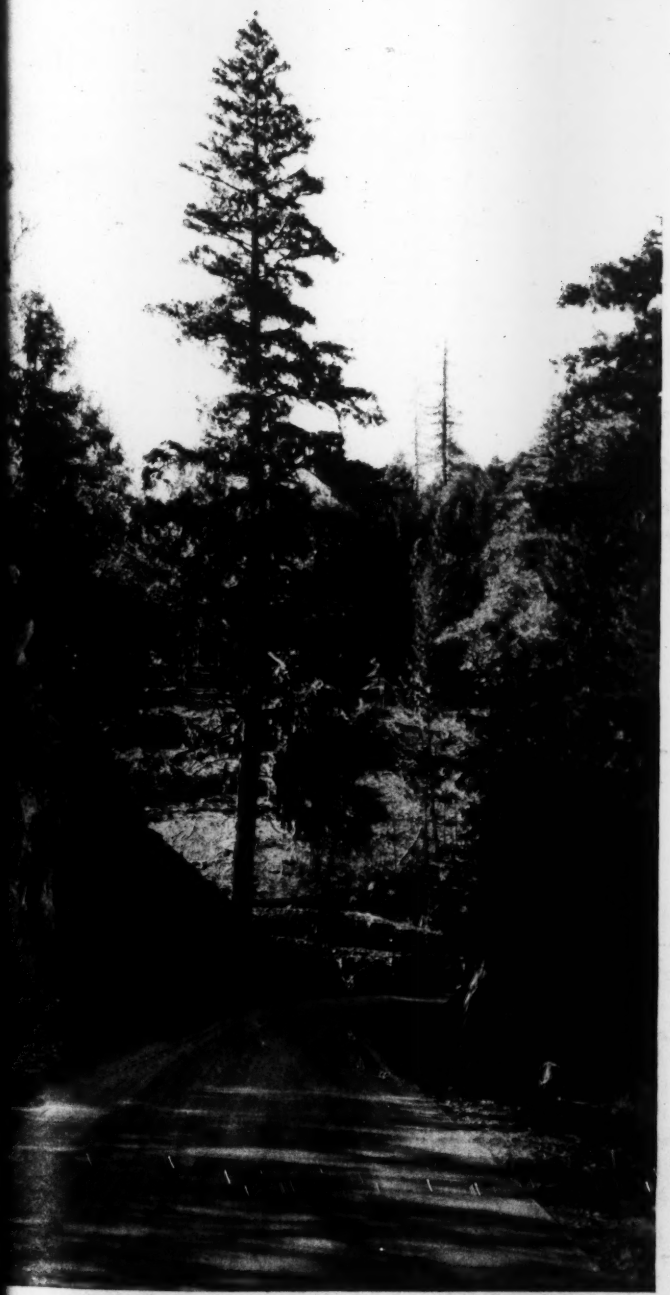

Pacific Highway Through the Siskiyous in Oregon

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Ten Short Highway 'Kink' Articles; and The Year's Progress in Road-Building Plant

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Company Inc.
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Editor

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Emphasizing Highway Engineering

IF A billion dollars a year is going into highways in this country—and that is the best estimate that can be made—the roadbuilding industry is engaging more engineers, more workmen and more contractors than any other one kind of construction. Next week the representatives of this major industry will assemble at Chicago to discuss its problems, formally in convention and informally in lobby, and at the comprehensive exhibition of machinery that will be provided. The meeting is made the occasion for this issue of *Engineering News-Record*, but no excuse is offered, or is in fact required, for this emphasis on one branch of engineering. Roadbuilding is not only the major interest of a great number of engineers and contractors but it is a potential source of work and effort for a great many more. Further than that it has implications and ramifications into political and economic fields which make it one of the most important of future public questions and one on which engineers, as a group, will be expected to be informed. The articles in this issue are frankly and intentionally for the most part specialized but the engineer or contractor who passes them over merely because he is not interested in that specialty is missing an opportunity to improve his future.

Smoothness Surveys

QUANTITATIVE measures of the condition of road surface have been set up in New York State. Beyond some straight-edge tests of pavement newly finished, past practice has used no measure other than the engineer's judgment to determine when surface renewal or reconstruction was necessary. By the new practice in New York, as described in this issue, a device called a vialog is attached to an automobile and, as the automobile travels over the road, inscribes a graph of the surface irregularities and casts up their sum in inches of vertical height. From the studied records of many miles of vialog surveys the New York division of roads has determined for each type of road a limit of vertical irregularities which represents satisfactory finish or the conditions of roughness when resurfacing or reconstruction are warranted. These limits are scheduled in the article on another page. They attract interest merely as a numerical statement of road roughness. The important observation however, is that they indicate an intelligent effort to define quantitatively a condition until now capable of being expressed only in qualitative terms. The new device will not do away with the need to use judgment in allocating resurfacing or reconstruction expenditures. No mechanical device can do this, but it promises a numerical means of comparing surface conditions over large mileages and so helping to preserve a balance of judgment.

Statistics

THOSE readers of the first-of-the-year statistics who are interested in construction must be in a very pretty confusion if they have followed the records put forth by the various experts. In one set they may read that the total cost of *building* construction in 1923 was $5,992,000,000; in another that the "total construction bill has been well over $3,998,000,000," in last week's issue of this journal that "important engineering projects" totaled $2,002,429,000, and, in the same issue, an editorial reference to a total of six billions for all construction. Volume of construction, building or otherwise, is not a thing that can be accurately ascertained. All figures must be in the nature of scientific guesses based on the best information available. The statistics put forth by this journal are, therefore, not offered as infallible but they are the result of the most painstaking effort to adjust actual recorded data to the possibilities of those known to exist but not accurately determinable. The recorded "large construction" figures we believe to cover practically all construction work above the minimum costs established in our listing; the remainder of our estimate is from other reports on small construction and residential building, outside the range of our own records, but adjusted to the known deficiencies of the other sources. The total is offered for what it is worth, as our best guess on a doubtful figure. In spite of the widely published statement, noted above, that building alone in 1923 totaled only sixty odd million below six billion, we stick to six billion as a fair estimate of the actual *total construction* in 1923. We fear the other statistician has been assuming that every building permit means a building completed.

Highway Accidents Again

PUBLIC attention is being focussed on highway accidents at grade crossings. Various safety organizations are urging positive action toward immediate grade separation. Little indication is given in the published statements, that the spokesmen for these organizations realize the immensity of the physical changes necessary or the reasonable period required to effect them. There is evident a somewhat better conception of the cost and of the problem of financing the work. Ideas as to ways and means are, as would be expected, vague, though the motor-vehicle owner is maintaining in full measure his remarkable popularity as a target for special taxation. Why, in the wholly warranted combat against highway accidents, concentrate the attack on railway grade crossings? They furnish, according to the few available records, only a minor percentage of the total fatalities and a very small percentage of the total accidents. Road intersections have proved almost as dangerous and

the really dangerous place is straight-away pavement in an excellent condition of surface. In a word, the far greater number of highway accidents, perhaps nine-tenths of them, are due to unskilled or careless driving. Under the circumstances it would seem a simpler, less expensive and more fruitful task to spend money to curb the careless driver. Let us go ahead with grade crossing elimination by all means, but let us keep in mind that it is one only of the highway traffic dangers which require elimination. The public is in danger of being "agitated" into unwise action if our thinking is not made more true than recent safety propaganda indicate that it is.

Oil Boosts Panama Traffic

FIGURES just made available show that the much-advertised increase in traffic in the Panama Canal is not due to a large increase in general canal traffic, but rather to an increase in the movement of tank ships carrying oil, mainly from the California fields. These ships make up 31.4 per cent of the total traffic. Geologists report at the same time that the principal southern California oil fields have reached their peak of production, which brings with it the accompanying prediction that tanker traffic through the Panama Canal will decline very rapidly, and it may disappear completely in a year or two. Other traffic is increasing through the Panama Canal, but it would be well to consider this oil situation in the various agitations which have been so prominent of late for an increase in capacity of the canal or of the building of a new canal.

Record Roadbuilding

ILLINOIS is fortunate, along with a few other states, in having a continuing highway administration. Its department heads, with few exceptions, have been in continuous charge since federal aid was first given eight years ago, and some of them have served even longer. Its chiefs of bureaus have served continuously through the period of heavy construction beginning in 1920. This continuity of personnel has, moreover, enabled the department to gather a following of contractors skilled through experience in roadbuilding and thoroughly trained in department practices—who have become, indeed, virtually a division of the department organization. The state is now reaping the advantages of its policy. Its division of highways constructed last year 1,024 miles of paved road, several hundred more miles than any other state has ever completed in a single construction season. Furthermore the organization is in position to repeat the performance in 1924 and thereafter in succeeding years when conditions warrant this high production. It takes close co-ordination to assemble into one working season all that goes to make up ten hundred miles of paved road. Such co-ordination is obtained, as the story told in this issue makes plain, only through the skill and teamwork which come from continuity of organization. To imperil an organization that can produce so convincing a record of efficiency is a serious thing. And yet political control in our states does not hesitate to do it, and to substitute for engineers, trained and experienced in the routine of good production under the peculiar conditions of the state, other engineers who must build up anew a program and a technique. Illinois last year made an enviable record. It remains to be seen whether the politicians can keep their hands off for another year.

A Beginning of Progress

IN PROPOSING rapid-transit connection of New York City with its New Jersey suburban district across the Hudson River, the transit authorities of the city have thrown a first faint ray of light into a dark situation. New York's metropolitan area extends many miles beyond the river, regardless of the state line, but the western suburbs are linked to the city only by ferries and by the shuttle-train service of the Hudson & Manhattan tunnel system. Some 300,000 people enter the city by these routes in the morning and return in the evening, and the hour lost each day by this great throng totals up to staggering figures of annual loss —loss to the city's production and wealth. That more effective interconnection is urgently necessary has been clear for many years. Quite uniformly, however, every proposal for such interconnection has met united opposition in the city. Merchants, city planners and officials standing together in this opposition have found in each instances that the difficulties of construction were insuperable, that the added traffic could not be taken care of in New York's streets, that some local interest was disturbed, or that some other equally conclusive reason existed for condemning the proposal. It has come to be an established fact that New York is interested only in adding the New Jersey water front to its own, and improving its freight supply system by a railroad belt line. That the real question at issue is the integration of the metropolitan district has been steadily ignored year after year; and meanwhile the problem has grown, until today it is easily the most serious of the city's development tasks. Its central element, obviously, is passenger transportation. Recognition of this part of the problem by the transit authorities, belated though it may be, is heartily welcome, as the beginning of official thinking of the subject. With such thinking once begun, ultimate action of constructive character comes into the range of realizable hope.

Highway Surety Bonding Reform

SURETY bonding practice requires overhauling. This assertion will be resented but it is true. Its truth is clearly indicated by the debate on another page between Messrs. Towner and Wilson. We have here the opposing attitudes of mind expressed about as clearly as in any discussion which has been published. It is evident, whichever cause we espouse or whether we support neither side, that there are differences of belief which must be adjusted if purveyors of contract surety and those who purchase it are to work well together. There cannot be continued discontent if the construction industry is to receive the full service which surety bonding can render.

There is at present wide discontent with premium rates, with the monopolistic character of the business, with the delay and expense of realizing on sureties, and, chiefly with the factitious financial strength which a bond gives a weak contractor. In highway work particularly, this discontent is being manifested by joint action of engineers and contractors to change legislation and practice. At the convention last month of the American Association of State Highway Officials, the report of the committee on relations with contractors, working with a committee of the Associated General Contractors, discussed chiefly ways and means of reform in contract bonding. At Chicago next week the

subject has a prominent place on the program of the American Road Builders Association and the following week it is discussed at length by the Associated General Contractors in convention.

Common action, to the extent indicated, for reform in bonding practice is too serious to be waved aside by surety underwriting experts with the remark that complaints are without understanding and querulous instead of constructive. Indeed so as not to arrive at an unfair decision the joint committee of contractors and highway officials postponed the definite recommendations which were expected and arranged to extend their consideration of the question in conference with representatives of the surety bonding interests. True agreement is sought and not a partisan decision.

It can be said from a rather close knowledge of how highway officials and road contractors are thinking on contract surety that it is their least desire to stampede the industry into ill-considered action. They both have too true a knowledge of the good purpose which surety bonding can serve and, in instances, is serving, to act hastily. But neither are they disposed to endure contemptuous dismissal of their protests against bonding conditions which they are convinced are an unnecessary financial burden and a restriction on engineering judgment. There is no use mincing matters. Those in charge of planning and constructing the nation's highways are determined that reforms shall be made in bonding contracts for road work.

The bonding companies have here an opportunity to assist in a task of construction co-ordination, to justify or adjust their practices which are alleged to be bad and in turn to demand the improvement of contracting methods of which they now complain. The whole truth of the surety bonding dispute is not on one side. On which side the balance of reform is cannot be determined by each side shouting invective at the other. There must be honest co-operation in the joint committee work which is planned. There should be active participation by the surety experts in the discussions which will take place in the coming conventions at Chicago.

Engineers and Highway Legislation

LEGISLATURES last year occupied themselves actively in making laws for public road improvement. Administration, financing, taxation and traffic regulation all received attention. A count of the acts can be only an approximation but such a count shows, in every state whose lawmakers met, some act affecting highways or highway transport and in the 44 states an aggregate of 132 changes in road laws. Little of this legislation was radical, although some of it was subversive of principles that have been considered sound and useful.

There is both assurance and a warning in this legislative activity. It is encouraging that the people are alive to the necessities of road development; most of the laws of last year provided additional sources of road money or regulated the use of roads. Their very alertness is also a cause for fear that there may be unwise financing and regulations which will throttle transportation. Chiefly, however, the danger of the exceeding willingness to legislate comes in the chances it offers to overthrow principles and policies of administration and organization that have proved their worth. By good fortune engineers have come largely into control of road building. They have organized the work as a continuing business. But it may not be forgotten that a public roads business of a billion dollars a year is a prize for which the professional politician will continue assiduously to strive. There was some legislation last year which was wholly subversive of good engineering and good business in highway development. There was far more of this sort of legislation proposed, some of it radically retrogressive, which was not enacted.

In view of the situation highway engineers may no longer evade the obligation to direct road legislation. It is not forgotten that they do this now in a measure. Often now the road department engineer is advised with in preparing legislation and often he initiates movements for desired legislation. There is, however, a broader task than these which he has only rarely performed well. It is the task of directing legislation by directing public thinking. Successful performance of this task is indicated as much by legislation which is not proposed as by the character of that which is enacted.

The last statement requires emphasis. Had the public been directed to think in terms of modern highway development, certain retrogressive road-administration acts proposed last year would never have reached the strength which enabled them to fight a stubborn action against all the forces concentrated for their defeat. Indeed they would never have been conceived. It is as much the function of highway department engineers to cultivate the sound thinking which prevents absurd legislation from being proposed as it is their function to combat such legislation after it has been proposed. And all the state highway departments, which are equipped to do and are doing this educational work, are not half a dozen.

Vigorous action is needed to keep road legislation where it belongs, to secure the statutes which will help development, to reject the acts which will retard sound growth and to keep all laws down to the least number that will serve. Legislative tinkering last year set back the program in every state in which it effected more than a nominal change. Even where most praiseworthy, the new acts necessitated a delay for readjustment. This is bound to be the case always. It is the tendency to multiply highway legislation. Arising problems of financing and of transport will increase the tendency. Repression will be necessary if we are not to have a snarl of laws that will trip progress. And again progress will be hampered if repression is not exercised with wisdom.

Altogether this year and in the next few years, state highway departments have a complex task of directing road legislation. Each department must depend largely upon itself in this task. It must organize and equip itself for the brunt of the battle. But engineering and contracting associations from the outside have power and they should put it forth. Engineering direction, as has been said, is more nearly predominant in public road improvement than in any other industrial development work which today engages the country's attention. By all their means engineers and constructors should work to maintain the situation. It is threatened only by law making based on the public lack of sound knowledge of highway engineering and highway transport and their requirements and cost. The engineers task is plain—active participation in highway legislation.

Theory and Calculation of Highway Transportation Cost

Economic Life of Road Analyzed—Annual Cost Formula Developed—Relation Shown Between Vehicle and Road—Formula for Vehicle Costs

By T. R. Agg
Professor of Highway Engineering, Iowa State College, Ames, Iowa

IN ECONOMIC comparisons of the various means that may be available or may be made available for conducting highway transportation there must be consideration not only of those costs that accrue on account of the highway but also of those that accrue on account of the vehicle. Actually these are closely related and quite often vary together. The total, or more properly, the true cost of highway transportation is a combination of vehicle costs and highway costs and neither is complete without the other.

Economic Theory of Road Costs—Without entering into a discussion of the various methods that have been suggested for computing the annual cost of furnishing highway service, this presentation will be based on the theory outlined by Gillette and Dana in "Mechanical and Electrical Cost Data" (McGraw-Hill Book Co.) which is believed to be not only fundamentally sound, but also easily applied to the problems of the highway engineer (to which position some of my colleagues take violent exception).

Roadway Surface Costs—The annual cost of the roadway surface during its economic life may be computed as follows:

$$C = M + (I - S)f + IR \qquad (1)$$

In this equation:

C = the annual cost per unit of roadway surface,

M = the equated annual cost of maintenance per unit of roadway surface,

I = the initial cost per unit of roadway surface, including administrative and engineering overhead,

S = the salvage value per unit of roadway surface at the end of its economic life,

f = the annual deposit that will accumulate $1 in a period equal to the economic life of the roadway surface, with interest at 4 per cent, compounded annually,

R = the rate of interest applicable to highway costs, taken herein at 4 per cent.

Having determined the annual cost per mile of surface one foot wide, the cost per ton-mile of traffic may be determined by dividing that cost by the average annual tonnage of traffic per foot of width of surface. It will be apparent that before calculations can be made in accordance with Formula 1, the proper values must be secured for the several terms.

Initial Cost—In applying the method to a specific highway it will usually be possible to determine the contract price of the roadway surface. To this must be added the cost of administration and engineering to obtain the factor I. Administration and engineering costs vary from 3 per cent in the case of well-handled, state-highway work to as much as 10 per cent in some municipal work. Where the exact data are lacking, 5 per cent may be used as representing a fair average.

Maintenance Cost—The cost of maintenance is often difficult to determine, since the records available are not always complete and do not cover a long enough period to make possible the establishment of a maintenance cost curve for the entire economic life period. Curve 1 in Fig. 1, showing the average total cost of maintenance at each year of age of a certain group of pavements in Buffalo, N. Y., is typical of the kind of information needed. If this curve is other than a straight line, it is necessary to take account of the time value of money in determining the average annual cost of maintenance during the economic life of the surface. That is accomplished as follows: Compute the sum to which the maintenance cost for each year would amount if placed at compound interest until the end of the economic life of the roadway surface. Add together all of these sums and then determine the annuity required to produce that quantity during the economic life of the roadway surface. This theoretical annual deposit is the factor M in Formula 1. If the curve of annual maintenance cost is a straight line, obviously the costs equate themselves and the arithmetical average cost may be used for the factor M in Formula 1.

Salvage Value—The salvage value of the roadway surface may be considerable or it may be zero, depending upon the type of construction and the type that is to be used to replace it. The concrete base of a sheet or block pavement can be utilized for some new type or the thickness of a new pavement may be affected by the existence of an old macadam or gravel roadway. In general, salvage value is the difference between the cost of a new roadway surface when constructed over some existing surface and the cost of the same type of new roadway surface when constructed in the same locality without utilization of an existing surface. Obviously the design for the new construction must contemplate the utilization of the old roadway or its full salvage value will not be realized.

Traffic—The average annual traffic to which a road-

TABLE I—ESTIMATED HIGHWAY COSTS IN DOLLARS PER MILE OF ROADWAY SURFACE ONE FOOT WIDE

Item	Type								
	Ordinary Earth	Best Earth	Ordinary Gravel	Best Gravel	W. B. Macadam	Bituminous Macadam	Sheet Asphalt and Asphalt Concrete	Portland Cement Concrete	Vitrified Brick
Right-of-way	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
Earth work	75.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Maint. of right-of-way	2.50	3.50	2.50	3.50	3.50	3.50	3.50	3.50	3.50
Maint. of surface	$150 + \frac{\text{A.T.}^{**}}{3{,}000}$ W*	$250 + \frac{\text{A.T.}}{3{,}000}$ W	$300 + \frac{\text{A.T.}}{3{,}000}$ W	$500 + \frac{\text{A.T.}}{3{,}000}$ W	$500 + \frac{\text{A.T.}}{3{,}000}$ W	$350 + \frac{\text{A.T.}^{**}}{4{,}500}$ W*	$100 + \frac{\text{A.T.}}{4{,}500}$ W	$80 + \frac{\text{A.T.}}{6{,}000}$ W	$50 + \frac{\text{A.T.}}{6{,}000}$ W
Cost of surface	.....	.....	100.00	200.00	700.00	1,000.00	1,800.00	1,650.00	2,200.00
Salvage value	.....	.....	.....	50.00	300.00	400.00	1,250.00	1,250.00	1,250.00
Economic life	.....	.....	.....	.....	6 yrs.	7 yrs.	15 yrs.	20 yrs.	30 yrs.

*W = Width of traveled way in feet. **A.T. = Traffic in tons per annum.

way has been subjected is difficult to determine because in the United States there has been little attempt to keep systematic records of traffic. British engineers have done rather better in this respect. In the absence of exact information in regard to the tonnage that necessitated the maintenance expenditure, comparisons of types may often be made on the basis of estimated *relative* volumes of traffic, but such estimates are of little value unless prepared by an engineer of long experience who is well acquainted with the territory in which the highways are located.

Economic Life—The economic life of a roadway surface has been attained when the annual cost becomes a minimum. It is conceivable that by careful maintenance a roadway surface might be continued in service after it had attained its economic life but the cost of maintenance would be such that it would prove economical to replace the roadway surface instead of endeavoring to prolong its life. In this connection it must be understood that the maintenance is handled so as to keep the roadway surface at its maximum of serviceability. If traffic is compelled to use inadequately maintained surfaces, vehicle operating costs are adversely affected and the burden of expense is transferred to the vehicle owner.

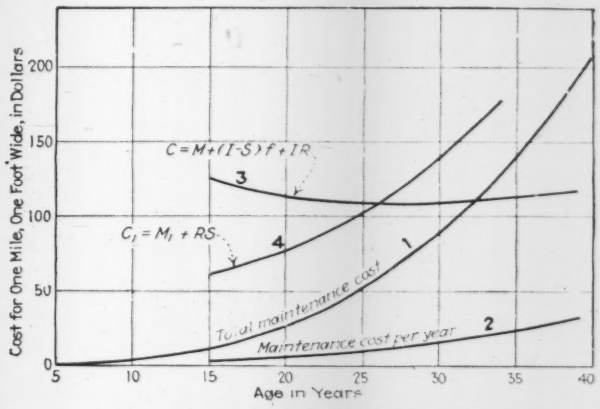


FIG. 1—COST CURVES OF ROAD SURFACE AND MAINTENANCE

TABLE II—AVERAGE ROLLING RESISTANCE AND RELATIVE FUEL CONSUMPTION

Type and Condition of Roadway Surface	Average Values Rolling plus Air Resistance: Solid Tires 10 m.p.h.	Pneum. Tires 15 m.p.h.	Pneum. Tires 25 m.p.h.	Pneum. Tires 35 m.p.h.	Relative Fuel Consumption with that on surface for which R = 30 lb. per ton taken as unity: S.T. 10 m.p.h.	P.T. 15 m.p.h.	P.T. 25 m.p.h.	P.T. 35 m.p.h.
Portland cement concrete, best, newly finished	30	22	27	35	1.00	0.89	0.96	1.07
Portland cement concrete, rough, due to poor work	36	30	35	42	1.08	1.00	1.07	1.16
Portland cement concrete, average good condition	32	27	32	39	1.02	0.96	1.02	1.12
Asphaltic concrete coarse graded type, average yearly temp.-best	30	25	30	37	1.00	0.93	1.00	1.09
Asphaltic concrete coarse graded type, average yearly temp. average	33	27	32	39	1.04	0.96	1.02	1.12
Sheet asphalt at average yearly temperature, best	28	23	28	35	0.97	0.91	0.97	1.07
Sheet asphalt at average yearly temperature, average	36	30	35	42	1.08	1.00	1.07	1.16
Bituminous filled brick, average, no filler on surface	30	26	31	38	1.00	0.95	1.01	1.11
Grout filled brick, average	37	30	38	45	1.09	1.00	1.11	1.20
Wood block bare of filler, average uniform surface	35	30	34	40	1.07	1.00	1.05	1.13
Gravel, best, clay bound	40	35	40	47	1.13	1.07	1.13	1.23
Gravel, fair to poor; rough spots some loose material	55	50	55	62	1.33	1.27	1.33	1.42
Gravel, poorest condition, rough and many loose places	60	55	60	65	1.40	1.33	1.40	1.47
Gravel, Iowa yearly average, approximated	50	45	50	57	1.27	1.20	1.27	1.36
Natural soil, good, well graded and patrol maintained	45	35	40	47	1.20	1.07	1.13	1.23
Natural soil, soft (or slightly "spongy")	70	70	75	80	1.54	1.53	1.60	1.67
Natural soil, Iowa yearly average, approximated	55	45	50	58	1.33	1.20	1.27	1.37
Snow, 2 in. thick and well packed	55	50	70	..	1.33	1.27	1.53	....
Snow, about 4 in. thick, slightly packed	75	70	..	..	1.60	1.53	....	....
Snow, about 4 in. thick, slightly packed, chains on wheels	75	..	..	..	1.60	....	....	....
Average for best paved surfaces, concrete asphalt, brick, and wood block	30	22	27	37	1.00	0.89	0.96	1.09
Average for partly worn pavements, i.e., in fair average condition	35	30	35	42	1.07	1.00	1.07	1.16
Yearly average for best gravel of type used on trunk lines	45	40	45	55	1.20	1.12	1.20	1.33
Yearly average for ordinary gravel found on secondary roads	55	50	55	65	1.33	1.27	1.33	1.47
Yearly average for well maintained earth roads, light traffic	65	60	63	75	1.47	1.40	1.44	1.60
Yearly average for well maintained earth roads, heavy traffic	55	50	53	65	1.33	1.27	1.31	1.47

At the end of its economic life, the roadway surface has deteriorated to its salvage value and no further depreciation need be considered. The annual cost of the service rendered beyond the economic life period is therefore computed as follows:

$$C_1 = M_1 + RS \qquad (2)$$

In this equation:

C_1 = the annual cost per unit of surface during any period beyond the economic life of the surface.

M_1 = the equated annual maintenance costs during the period.

R and S have the same significance as before.

There is no depreciation term in Formula 2 because by the very assumption upon which the formula is based the surface has already reached its economic life and therefore its maximum depreciation.

Computing Economic Life—Formulas 1 and 2 afford a means of actually computing the economic life of a roadway surface, for by means of Formula 1 the cost of service from a new surface can be estimated and by means of Formula 2 the cost of service from an existing surface can be computed and whenever C_1 becomes greater than C the economic life of the surface has been exceeded.

This will perhaps be clearer from the following illustration. Since the character of the traffic will be the same on a new as on the old surface (if the old is properly maintained), traffic tonnage may be disregarded in computing economic life.

Assume the cost of maintenance to follow Curve 1 in Fig. 1. The cost of a new roadway surface to replace the existing one is $1.55 per square yard and its salvage value will be zero. The initial cost of the existing surface was $3.30 per square yard and its salvage value is $1.75 per square yard. Interest is to be at the rate of 4 per cent in all calculations and compounded annually.

Calculate the value of C on the assumption that the economic life of the existing surface is 20 years. Then recalculate on the assumption that the economic life is 25 years, and again on the assumption that it is 30 years. In this way enough points can be obtained to determine Curve 3, Fig. 1.

If the assumption that the economic life is 20 years were correct, Formula 2 could be used for determining the cost for the 21st year. Likewise if the assumption that the economic life is 25 years were correct, Formula 2 could be used for computing the cost for the 26th

year. In this way enough points could be computed to determine Curve 4, Fig. 1.

The intersection of Curve 3 and Curve 4 determines the economic life of this particular pavement to be 27 years. At the age of 27 years the annual cost per unit of pavement is very nearly $1.10. The life tonnage is unknown for this particular case but by comparing with other pavements in similar locations it is estimated to be 6,000 tons per foot of width per annum, and the total annual roadway surface cost is therefore nearly 2c. per mile one foot wide per ton of traffic.

Application to Highway Systems—A state highway system is constructed section by section, over a long period of years. If each section is well cared for and is

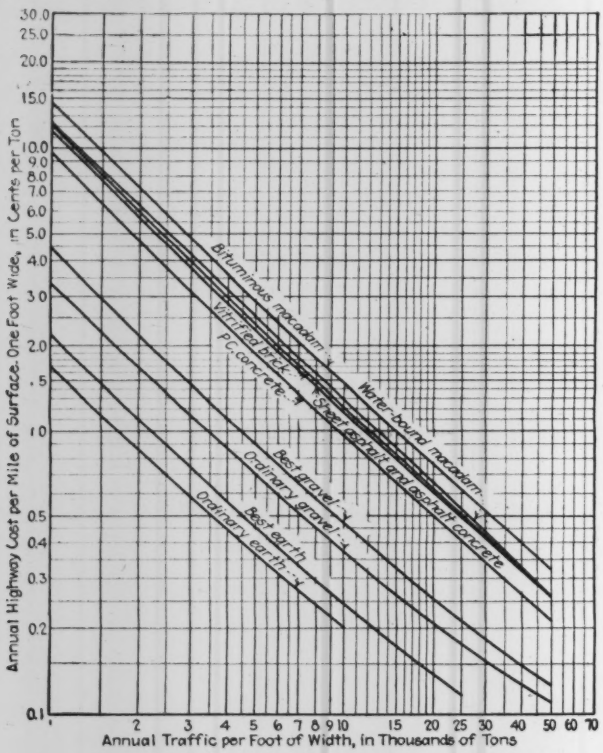


FIG. 2—TRAFFIC COST CURVES FOR DIFFERENT ROAD SURFACES

replaced when it reaches its economic life, the average annual expenditure for the maintenance of each type of roadway surface comprising the system will be very nearly the same as the theoretical equated annual cost of maintenance. In computing the actual annual cost of a system of highways it is perhaps sufficiently accurate to use the recorded average annual maintenance costs for each type since certain other factors must be estimated in any case.

In any administrative area the economic life for each type of roadway surface should be determined in enough instances to establish the average economic life for various traffic densities, and, similarly, the maintenance cost, salvage value and other factors should be evaluated by analysis of the data pertaining to a large group of roadway surfaces of each type.

It has been impossible to do that with certainty heretofore because of lack of published data but from a study of all of the records available there has been prepared a list of tentative average values for these various quantities which are given in Table I. In any state or city the records would doubtless show where the factors presented herein could be revised, but those in the table will illustrate the method of attack and incidentally illustrate how helpless the engineer becomes if he cannot secure suitable fundamental data for his computations.

Relation of Maintenance Costs to Volume of Traffic—It is recognized that there is a relation between the cost of maintenance of a roadway surface and the quantity of traffic but there have been few attempts to measure the effect of increasing traffic on maintenance costs. In some cases the increased cost has been attributed to the increased age of the roadway surface when in reality it is due to increased traffic. From an analysis of such records as have come to hand it appears that the variation in cost of maintenance with a change in traffic may be estimated from the following formula:

$$\text{Average maintenance cost} = K + \frac{\text{Average Annual Traffic in Tons}}{P}$$

The factors K and P are wholly arbitrary and their values will vary in the states according to climatic and traffic conditions. For Iowa they appear to have values as follows:

	K	P
Ordinary earth	.150	3,000
Best earth	.250	3,000
Ordinary gravel	.300	3,000
Best gravel	.500	3,000
Waterbound macadam	.500	3,000
Bituminous macadam	.350	4,500
Sheet asphalt and asphaltic concrete	.100	4,500
Portland cement concrete	.80	6,000
Vitrified brick	.50	6,000

Additional Items of Cost—The roadway surface has been discussed in the foregoing analysis but the true cost of providing a highway must include some additional items and the annual cost of each of these may be computed from Formula 1 by inserting appropriate values for the various terms.

Right-of-way Costs—The item of maintenance of right-of-way is the cost of cutting weeds, cleaning out ditches, preventing or repairing damage from erosion and similar upkeep. Since these costs do not vary greatly from year to year they equate themselves and the average cost may be used instead of the equated cost of maintenance used for roadway surfaces. This item varies greatly according to soil and climatic conditions but ranges from $50 to $150 per mile per year for trunk line highways.

Much discussion has been had concerning the proper interpretation of the term $(I - S)f$, as applied to right-of-way. In the case of old established roads the original right-of-way was taken from the adjacent lands and will revert to them if abandoned, or in effect I and S are equal and the term $(I - S)f$ vanishes. If the right-of-way was actually purchased in any case it is exceedingly difficult to predict its salvage value but it is safe to say that in the vast majority of cases it would equal the initial cost and it might exceed it. However, the cases of abandonment are so few that no consideration need be given to that possibility. When the right-of-way continues in use for a long period of time f becomes so small that it does not affect the annual cost for right-of-way. No serious misconception will result in the usual case by considering the term $(I - S)f$ to equal zero.

The term IR remains and herein lies another possible source of error. Even if the right-of-way were donated

or simply taken from adjacent lands it should be considered to have value and that value is that which the land possesses now, whatever may have been the price when the land was dedicated to highway purposes.

From the foregoing it will be apparent that the element of transportation cost arising on account of right-of-way really reduces to the two terms, maintenance and interest.

By following a similar analysis, the transportation cost arising out of the construction of bridges, culverts, guide signs and various incidentals may be computed. These annual costs added to that of the roadway surface afford a correct measure of the portion of highway transportation cost that accrues from the construction and maintenance of the highway.

Total Highway Costs—Following the methods outlined in the preceding discussion and using the data in Table I as a basis, there have been prepared estimates of the actual total annual costs of highways with various classes of roadway surface and having traffic densities ranging from 1,000 tons to 50,000 tons per annum per foot of width exclusive of the exceedingly variable item of bridges and culverts. These are shown in Fig. 2, and it will later appear that considerable error may exist in these costs without materially changing the relative total cost of transportation on the various types of roadway surface.

TABLE III—VEHICLE OPERATING COSTS IN CENTS PER TON-MILE

	Type and Speed of Vehicle			
Type of Surface	Solid Tire Trucks Speed 10 m.p.h.	Pneumatic Tire Trucks Speed 15 m.p.h.	Automobiles 25 to 35 m.p.h.	Motor Buses (Cents per Bus-Mile 25 m.p.h.
Average P.C. concrete and asphalt filled brick	8.0	8.3	10.0	24.0
Best P.C. concrete and asphalt filled brick	7.75	7.7	9.3	22.5
Best gravel, yearly average	8.5	8.8	10.9	25.7
Ordinary gravel, yearly average	9.0	9.4	11.8	27.8
Waterbound macadam, well maintained	8.7	8.95	11.1	26.0
Bituminous macadam, well maintained	8.5	8.8	10.6	25.7
Average sheet asphalt, yearly average temperature	8.1	8.3	10.0	24.0
Average asphaltic concrete, yearly average temperature	8.0	8.3	10.0	24.0
Best earth, well packed by traffic, yearly average	9.0	9.4	11.7	27.8
Ordinary earth with light traffic, yearly average	9.5	9.95	12.6	29.6

Economic Theory of Vehicle Costs—The total cost of vehicle operation may be computed from the following modification of Formula 1.

$$C_v = \frac{M_v + O_v + (I_v - S_v)f + I_v R}{T_v} \qquad (3)$$

In this equation

C_v = the average cost of the vehicle per ton-mile during its economic life.

M_v = the equated annual cost of maintenance of vehicle during its economic life.

O_v = the average annual cost of operation of vehicle during its economic life.

I_v = the initial cost of the vehicle.

S_v = the junk value of the vehicle at the end of its economic life.

f = the annuity that will accumulate $1 during a period equal to the economic life of the vehicle, using interest at 6 per cent, compounded annually.

R = the rate of interest applicable to the investment in the vehicle, say 6 per cent.

T_v = the average annual ton-miles of travel.

If these items of cost are known for any vehicle, the actual economic life and the average cost per ton-mile for operation can be computed. Such an analysis is primarily of interest to the vehicle owner. The highway engineer is concerned with the cost of operation only as to its total and the effect thereon of highway conditions.

TABLE IV—SHOWING TOTAL ANNUAL COST OF TRANSPORTATION IN DOLLARS PER MILE

(Assuming 90 per cent of tonnage is Automobile; 10 per cent Truck. ¾ of truck is pneumatic tire, ¼ solid tire).

	18 Foot Surface Annual Traffic in Tons per ft. of Width					
	2,000	5,000	10,000	15,000	25,000	50,000
Ordinary earth	4,672	11,411	22,524			
Best earth	4,520	10,718	21,049	31,328	52,043	
Ordinary gravel	4,761	11,016	21,442	31,868	52,718	126,000
Best gravel	4,649	10,434	20,056	29,711	48,992	97,182
Waterbound macadam	6,166	12,597	21,171	31,691	51,325	100,319
Bituminous macadam	6,391	12,033	21,413	31,162	49,577	96,507
Sheet asphalt	5,635	10,951	19,812	28,674	46,393	90,702
Asphalt concrete	5,633	10,947	19,804	28,661	46,373	90,648
Average P.C. concrete	5,253	10,563	19,415	28,266	45,967	90,225
Best P. C. concrete	5,011	9,958	18,204	26,451	42,941	84,173
Vitrified brick	5,682	10,990	19,843	28,696	46,395	90,648

Costs for Groups of Vehicles—Highway traffic is made up of large numbers of vehicles of many types, driven by operators of varying degrees of skill and intelligence and hence highway transportation costs must be based on average costs for large groups of vehicles. Vehicle costs are made up of averages for all vehicles using the highway, and if the cost for each vehicle is kept to the minimum by proper operation and care (which can never be accomplished fully) the average cost will represent the true actual cost of vehicle operation. An average vehicle operating cost of some kind must be used in economic analyses of highway transportation costs and no matter how carefully it is computed it can never represent exact actual operating costs for the individual vehicle.

Relation Between Type of Highway and Vehicle Costs—It is generally recognized that there is a relation between the type and condition of the roadway surface and the cost of such items as fuel, oil, tires, repairs, maintenance and depreciation but the exact relation can be established only after long investigation. In some investigations of rolling resistance conducted by the Iowa Engineering Experiment Station, Ames, Iowa (*Bull.* 67), and by the Michigan Highway Department (Power characteristics of motor trucks, in *Report of Fourth Annual Conference* of Michigan Good Roads Association), it was found that there is a definite relation between the rolling resistance of the road surface and the fuel consumption of the vehicle. Based on these investigations, the data in Table II have been computed to show the approximate relation between the type and condition of roadway surface and the fuel requirements of various types of vehicles.

In a thesis H. S. Carter (now an instructor in civil engineering at Iowa State College) analyzed the records of operating costs for over a thousand motor vehicles that were employed in many kinds of service. He found that the ratio of fuel cost to total operating cost was surprisingly uniform over a wide range of operating conditions. He also found that for each class of service the ratio of operating cost to total cost was quite consistent for each class of vehicles. This general relation seems to be confirmed by bits of information gleaned here and there in reports of vehicle operating costs, but it is by no means fully established. Operators of large fleets of vehicles watch fuel consumption very closely since they have learned that it is an accurate index of total operating costs.

For estimates of the effect of road condition and type upon vehicle operating costs, it is herein assumed that operating costs will vary with fuel costs and that the

relative cost of vehicle operation for different classes of road surface may be estimated from the following:

For commercial vehicles except buses:

$$C_t = 0.5C_b + 0.5C_b\frac{F_t}{F_b}$$

For motor buses:

$$C_t = 0.4C_b + 0.6C_b\frac{F_t}{F_b}$$

For automobiles:

$$C_t = 0.25C_b + 0.75C\frac{F_t}{F_b}$$

Where

C_t = the total vehicle cost for any type of surface.

C_b = the actual cost for a type of surface taken as a basis of comparison (taken herein as one for which the rolling resistance is 30 lb. per ton).

F_t = the rate of fuel consumption on the type for which C_t is being determined.

F_t = the rate of fuel consumption on the basic type.

Table III shows the relative total cost of vehicle operation for various types of road surface. In its preparation the basic cost of operation was determined for each group of vehicle from an analysis of some hundreds of records of operating costs. The costs for other types of surface were then computed as was explained. It is believed that the *relative* costs of operation shown in the table are ultra conservative for the lower grade surfaces and that the table will be useful for comparative purposes as well as in illustrating a method of analysis.

Combined Vehicle and Road Costs—Having determined the vehicle cost per ton-mile for any type of surface and the cost of the highway per ton of traffic, the total cost of highway transport is obtained by adding the two quantities.

Since this quantity will vary with the volume and character of the traffic general tables cannot be prepared, but must be computed for each group of highways of comparable nature. To illustrate the results of such an analysis Table IV has been prepared which is applicable to many highways in the upper Mississippi valley. Since the relative costs in the table depend primarily upon the accuracy of the data in Table III, rather than those in Fig. 2, care should be exercised to insure that vehicle operating costs applicable to the locality are used.

Czechoslovakia Develops Large Water-Power

The Czechoslovak government, realizing the importance of coal as an item of exports and the necessity of curtailing consumption of coal by domestic industries, is contemplating extensive improvements to develop and conserve the country's water-power, according to a report by American Consul C. S. Winance, at Prague. The most important project now under consideration is the building of three dams across the Thaya river, near the Austrian border. The first dam will be constructed between Bitov and Vranov, making a basin of 180,800,000 cu.m. content; the second dam will be near Podmole and will create a basin of 16,300,000 cu.m. content, and the third dam will be constructed at Znojmo and will create a basin of 7,000,000 cu.m. content. It is stated, the consul says, that the dams of the Thaya will be the largest in Central Europe. The work has been begun under the direction of the Czechoslovakia national government and the Moravian provincial administration.

Swamp Road Building Among the Indiana Sand Dunes

Dragline Half-Floating on Soft Marsh Land Builds Parallel Muck Dikes and Fills Between Them With Sand

By H. M. Herald
Project Engineer, Indiana State Highway Commission, Indianapolis, Ind.

About five miles of swamps, with which the famous Indiana dune lands are spotted, are crossed by the new highway recently completed between Michigan City and Gary. When the great glacier swept down into what is now northern Indiana and then receded it left a lake in this region more than fifty feet above the level of the present Lake Michigan. The major portion of the waters from the lake thus formed drained into the Illinois River, finally reaching the Mississippi. After being partially but not wholly drained in this manner, the marshes across which the Dunes Highway is constructed were formed. They consist of fine sand covered with from 5 to 12 ft. of decayed vegetation, which has reached the early stages of peat. In the spring and fall these marshes are submerged under from 2 to 3 ft. of water.

As located the new road eliminates nine dangerous railroad grade crossings and seven miles of distance between Michigan City and Gary. It was for this reason that this route was selected, even though it presented many construction difficulties. The contract (Indiana Federal Aid Project 31, Section A), approximately seven miles in length, was awarded to the General Construction Co., Gary, Ind., on April 26, 1922, at a total price of $178,390.77. However, it was found during construction that all sections of the pavement, as originally planned, would not be above extreme high water and it was decided to raise the grade 1 to 2 ft. through certain sections, which increased the contract price.

The contract provided for two classes of excavation, ordinary and special borrow. Ordinary excavation included all excavation done within the limits of the right-of-way. Special borrow included excavation of borrow pits without the limits of the right-of-way.

Immediately after the contract was awarded, the contractor asked permission to make a borrow pit along the south side of the Miller marsh at the west end of the road. This permission was granted with the understanding that the borrow pit would be kept far enough away from the toe of the slope to prevent any possibility of the fine sand flowing into the borrow pit. It was also agreed that the muck, which was to be stripped from the borrow pit, would be placed on either side of the new grade not less than 5 ft. from the edge of the pavement, but that no yardage would be allowed to the contractor for the stripping so placed.

The excavation through this marsh was started on May 19, 1922, with a 40-ton steam shovel, equipped with a 1-cu.yd. dragline bucket. The excavator started at Sta. 15 and was set in action on a line 10 ft. south of the center line of the road. This position would allow the 40-ft. boom to cast out 20 ft. beyond the south right-of-way line, and with a swing of 180 deg. to cast the muck or stripping on the north side, out a distance of 15 ft. north of the center line. In this

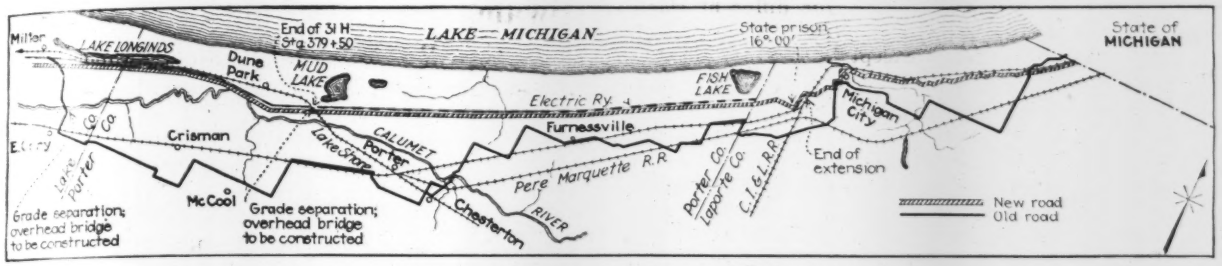


FIG. 1—DUNES HIGHWAY FROM MICHIGAN CITY TO GARY
New location reduces distance about seven miles and eliminates nine grade crossings.

manner a dike constructed of the stripping was built on either side of the road and the new sand fill placed between the dikes. The heavy excavator was placed on wooden mats resting on top of the muck. Very good progress was made from Sta. 15 to Sta. 27 without any accidents or delays. At Sta. 27, however, the shovel slipped off the mats and penetrated the muck to such a depth that the fire was extinguished by the marsh water.

It was first attempted to lift the excavator with hydraulic jacks to a height sufficient to get the water out of the fire box, but this method failed. It was then arranged with the Chicago, South Shore & South Bend Electric Line, which the new road parallels very closely, to pull the excavator from the muck with electric motor equipment. After five days and nights of continuous work the 40-ton piece of equipment was again placed in action.

After working at this point some four or five days without making much headway on account of the enormous depth of muck, it was decided to move ahead and skip this particular section, this section to be completed with a lighter machine. A second machine was now installed, a light excavator with only a 30-ft. boom, equipped with a clamshell bucket. The original bucket with which this machine was equipped was not a success and another type of bucket was secured. The smaller machine was started at Sta. 100 and worked towards the west to meet the shovel. This, being a much lighter machine and only able to carry a 30-ft. boom, had to excavate closer to the berm and naturally, with a clamshell bucket, had to dig straight down, giving the borrow pit a vertical back slope, which was very objectionable. The small machine, however, did a very small percentage of the excavation, the greater portion being done by the heavier dragline. The two machines met at Sta. 87 on July 15.

The dragline continued eastward, moving up to Sta. 100. Excellent progress was made with this machine, as the muck pockets were gradually becoming fewer and sand ridges were in evidence. Grading was finished at Sta. 116 on July 31.

The contractor started laying pavement on July 24 at Sta. 95. The pavement is a concrete slab 20 ft. wide, 7 in. thick at the edge and 8 in. at the center, reinforced with 56 lb. of ⅜-in. steel rods per 100 sq. ft. From 500 to 600 lin. ft. were laid daily with the five-bag batch, 21-E mixer. The mixer arrived at Sta. 42 + 10 on Aug. 16.

At this point the chief engineer of the state commission, C. Gray, decided that it was advisable to discontinue paving operations for the season on this section, in order that the grade west from Sta. 42 might have a good chance to settle during the winter months. Accordingly, the mixer was moved to Sta. 94 + 75 and paving was resumed from that point eastward.

Paving operations were discontinued Oct. 20 on account of difficulties in securing right-of-way at this point as well as because of the lateness of the season. The contractor requested permission to concrete the

FIG. 2—A DIFFICULT PIECE OF ROAD MAKING
Dragline in the Miller marsh near Gary, Ind., making the fill for the foundation for a new road.

4,200 ft. of finished grade on the west end, but this permission was not granted by the chief engineer on account of the condition of the fill. The grade was allowed to stand until the following April, when the slab was poured and as a result it was conceded by all familiar with the work that this particular section of the pavement is at this date in perfect condition, so far as any settlement is concerned.

The dragline, in the meantime, had completed the grade to Sta. 148, where the side borrow ditch was discontinued. At this point the grading ran into cut. The contractor continued with the dragline in these cuts, although it was necessary to cast and recast the dirt at some points. The machine proved very economical from Sta. 148 to Sta. 175, where the ground was broken in such a manner that the greater portion of the material had to be cast but once. Beyond Sta. 175 the grading was done with wheelers, except in the two remaining marshes, known as the New York Central marsh and the Calumet marsh.

Across the New York Central marsh, which extended from Sta. 183 to 204, the fill required approximately 20,000 cu.yd. of material. This was secured between Sta. 178 and 183, by making a borrow in a high sand

dune. The fill was placed by an industrial railway. The fill across the Calumet marsh, which extended from Sta. 285 to 334, was made in a similar manner, by hauling the material in from adjacent sand dunes by industrial railway.

Paving operations were again resumed early in 1923, and the paving was completed Oct. 26. All swamp sections of pavement were reinforced as described above. All other sections of pavement were plain concrete 7 in. thick at the edge and 8 in. at the center.

It was assumed that the settlement would possibly be greater on one side of the pavement than on the other, due to a variation in the depth of muck, but that the difference in settlement would be so slight in the width of the pavement that it would not be serious. Observations of the sections of pavement laid over the west marsh during 1922 indicate that there has been a side settlement at different points not to exceed 0.4 ft. A flat grade was laid across the marsh sections and a recent inspection indicates that there has been a change in the profile due to settlement. The depressions in the pavement, however, are uniform and not abrupt, so

FIG. 3—INDUSTRIAL RAILWAY FILL ACROSS CALUMET MARSH

that the riding qualities of the pavement have not been seriously impaired.

The fact that very few cracks, either longitudinal or transverse, have developed is evidence of the uniformity of the settlement. In fact, there are fewer cracks than might be expected on a plain concrete slab of the same design on clay fills.

It has been suggested that the proper method of preparing the fills across the marshes would have been to remove all the peaty formation from above the sand and replace it with clean sand from an outside source. The cost incurred by such a procedure would have been prohibitive. The work is of such a texture, and so thoroughly saturated with water, that it would have been more expensive to remove than ordinary excavation. A very conservative estimate on this basis indicates that this method would have increased the excation by approximately 280,000 cu.yd. The cost of this additional excavation, based on the unit contract price of 75c. per cubic yard for borrow, will show that we can have a complete failure of the entire new slab for less money than we could have done the additional excavation which would have been required by this method. However, no contractor could have done the excavation in this manner, at a unit price for the pavement at which the excavation is being done under the plans adopted. It was assumed at the beginning, and

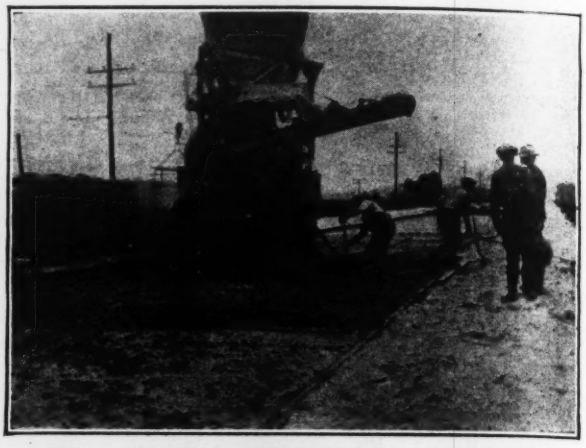


FIG. 4—PUTTING CONCRETE SLAB ON CALUMET MARSH GRADE

the opinion still is held, that within a few years it will be necessary to replace a few short sections of the slab, due to unequal settlement on opposite sides of it, but the cost will be small in comparison with the saving of excavation by the plans adopted.

Since the placing of this contract, a contract has been awarded by Lake County for a large drainage ditch across the Calumet marsh. This drainage ditch will cross the new highway and will necessitate the construction of a bridge with a total span of approximately 200 ft. If this ditch, when excavated, thoroughly drains the marsh, it will quite likely result in a heavier settlement of the pavement. The effect on the reinforced pavement slab will depend entirely upon the uniformity of such settlement.

It is anticipated that this section of road between Michigan City and Gary will be called upon to carry more traffic after the completion of the state primary system than any other road in the state, if not in the middle west. This will be the shortest route for all Chicago-bound traffic from all points east and northeast, coming through Ohio and Michigan, as well as all traffic from the north and west through Chicago to the east. It is anticipated that the amount of traffic on this section of road will, in the course of a few years, demand that the width of the pavement be increased to at least 36 ft.

Pasadena Sewage Farm Operation

The sewage farm of Pasadena had 76 acres of walnut trees, 65 acres of orange trees, 10 acres of grapefruit and a "large acreage" cropped with seed potatoes, corn and alfalfa during the year ending June 30, 1923, according to the annual report of C. W. Koiner, city manager. The entire sewage farm has an area of 510 acres. With the completion of the activated-sludge plant now under construction the effluent will still be applied to the orchards, but under more favorable conditions than now.

Deck on Lucin Cutoff Trestle Renewed Under Traffic

Rot Caused by Rainwater Necessitates Renewal—New Deck Has Watertight Cover—Timbers "Treated" in Lake Water

AFTER twenty years of service the untreated timber deck of the Lucin Cutoff across Great Salt Lake is being renewed. The main line single-track portion of this trestle is 11.9 miles long with 3 miles of additional sidings and second track. Features of the work are the methods of accomplishing the renewal without interrupting traffic and the salt treatment being given to the new deck timber on the strength of the fact that the original piling is still perfectly sound due to the preservative effect of the intensely salty lake water.

This structure carries a ballasted deck 16 ft. wide between side railings. The original ballast was com-

FIG. 1—NEWLY LAID DECK WITH CRUSHED ROCK AND 90-LB. RAIL

posed of gravel, which, though giving an easy riding track, is believed to have retained rainwater and thus contributed to the decay of the top surfaces of the trestle timbers. With protective measures to eliminate this danger, it is hoped that the new deck now going in will give even more than twenty years of service.

Salt treatment—The question of what would be the best preservative treatment for the trestle timbers in the renewed deck drew attention to the fact that the original piling of the trestle is still in perfect condition. The water in which this piling stands contains from 14 to 23 per cent of saline constituents, according to depth and location, as compared to an average of 3.5 per cent for sea water. The lake water is not only a saturated solution, but contains crystallized salts in suspension and when temperatures are low these salts even precipitate on piling and timbers. This salty lake water itself was considered to be a wholly satisfactory preservative.

All Oregon pine to be used in the new deck was therefore treated by immersion in the lake. Experiments were made to determine the necessary length of time for this immersion. It was found that after soaking for 90 days, the salt content for the outer ¼ in. of an exposed timber was about 2 lb. per cubic foot; furthermore, that the content decreased gradually

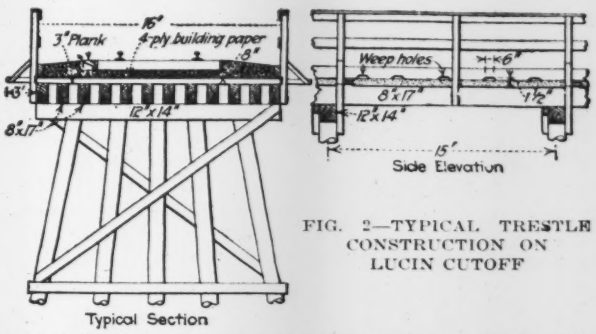


FIG. 2—TYPICAL TRESTLE CONSTRUCTION ON LUCIN CUTOFF

toward the center, and was about $\frac{1}{10}$ lb. at a depth of 3 in. Salt continued to enter the specimens after 90 days, but wave and storm action often caused an agitation of the floating timbers so that the surface quantity was leached away to some extent, reducing the content to about the amount accumulated in 90 days. The minimum time for soaking was therefore set at three months.

In this connection it is interesting to note that a pile which had been in the trestle for ten years or more was found to have in the outer ¼ in. of exposed surface a salt content of 7 lb. per cubic foot. The salts had penetrated to the heart of the pile and there, 6 in. from the surface, the content was $\frac{1}{10}$ lb. per cubic foot.

It has been planned to complete the renewal of the trestle deck in five years, doing 3 miles per year. This rate has been maintained for the first two years, 6 miles having been renewed to date. The trestle structure is similar to that used elsewhere on the Southern

FIG. 3—SALT PRECIPITATION OCCURS DURING COLD WEATHER

The waters of the lake do not freeze, but when chilled to low temperatures the supersaturation causes the salts to deposit on trestle timbers as shown.

Pacific System with the exception that the deck is one foot wider. It consists of 5-pile bents at 15-ft. intervals, 12x12-in. caps, 8x17-in. stringers, 3-in. planking and 15 in. of ballast. The 3-in. planking is redwood and all other timber Oregon pine.

Waterproofing—In addition to the salt treatment, several waterproofing measures have been adopted. A heavy coating of creosote oil is applied to the top surfaces of caps and stringers. A strip of roofing paper is placed between the tops of stringers and the bottom of floor planking. The planking is then covered with a layer of 4-ply roofing paper with a burlap base, the covering being extended down over the plank ends and great care being used to avoid unnecessary nailing. This paper is lapped 6 in. and is then covered with hot asphalt, using about 1 lb. of asphalt per square foot of floor surface. In order to provide better drainage the new ballast is crushed rock, with the exception of a 1½-in. cushion of gravel on the bottom to prevent abrasion of the waterproof cover.

Construction—Because of the difficulty and delays due to working in such limited space under traffic, the schedule of 3 miles of renewed deck per year requires

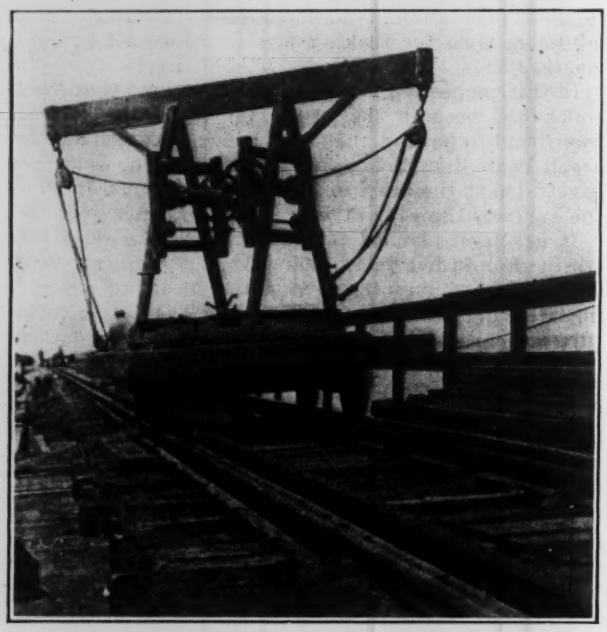


FIG. 4—DEVICE FOR HANDLING STRINGERS IN RENEWING BRIDGE

that several gangs work simultaneously at different points. About 28 trains cross the trestle every 24 hours, or an average of one every 50 minutes. Gangs of 30 bridge men and 30 track men complete six or seven 15-ft. bents per day. Materials are handled with a work train assigned solely to the project. Incidental to this about 1,200 30-ft. stringers and 200,000 ft. b.m. of 3-in. planking are used per month.

Since the stringers are 30 ft. long, the procedure is to renew the deck in 30-ft. lengths. Longer sections cannot be handled because of limited space alongside the track in which to place material removed, or to store that waiting to be installed. Because of the tendency of the rails to run and kink out of line when unballasted, it has been found necessary to keep the gangs widely separated, and replace ballast quickly.

The old ballast is first dug out and removed, each tie being blocked up. The blocking is then removed and the old roofing paper taken up. This process may be interrupted by the necessity of returning the blocks to let trains pass. The planks are then removed and the stringers slid out and replaced. The device for handling these stringers is shown in the accompanying view. The new planking, waterproofing and ballasting follow with comparatively little difficulty; and with renewal of the railings the section is completed.

Grade Separation on Federal-Aid Roads

Washington Correspondence

THIRTY per cent of all grade crossings on highway projects submitted to the Bureau of Public Roads are eliminated either by relocation or by the construction of underpasses or overhead crossings. This point was made by Thomas H. MacDonald, in the course of remarks before the National Motorists' Association, at its recent Washington meeting. Of the remaining 70 per cent of grade crossings, Mr. MacDonald pointed out, a large number are industrial spurs, sidetracks and minor branches, probably not more than 50 per cent being major crossings, while 75 per cent of those eliminated are major crossings. So in eliminating 30 per cent of all crossings fully 50 per cent of all major crossings on federal-aid projects are eliminated.

A total of 14,772 miles of all types of federal-aid highways were under construction on June 30, Mr. MacDonald stated. He gave the total estimated cost as $274,080,163.53, subdivided as follows:

Type	Estimated Cost	Miles
Grade and drained	$27,168,365.31	3,276.3
Sand clay	10,457,566.16	1,384.9
Gravel	57,705,338.64	5,136.2
Water-bound macadam	12,054,977.64	578.6
Bituminous macadam	41,215,734.06	1,365.2
Bituminous concrete	9,784,012.20	252.7
Portland cement concrete	96,155,843.03	2,525.6
Brick	9,785,163.83	224.2
Bridges	9,753,167.66	28.0

In another address before the Governmental Research Conference, also held in Washington, Mr. MacDonald urged an adequate city plan of coping with the traffic problem in cities. He urged the widening and straightening of streets; the elimination of encroachments; new streets, detours and diagonals; elevated streets; limitation of parking in congested areas, and paving to suit traffic needs. He urged street zoning and classification. He pointed out that streets should be wider in the business sections, but that unnecessarily wide streets in residential districts constitute an economic waste. A normal residential street, he suggests, should be 50 ft. wide, with a roadway width of 24 ft., whereas a 50-ft. street with a 32-ft. roadway should be considered the minimum for a business street. Mr. MacDonald was emphatic in urging regulation of pedestrian traffic and the efficacy of the one-way street in the relief of congestion.

Accidents at Railroad Crossings

That 97 per cent of automobile drivers display reasonable care in driving over railroad tracks and that the majority of accidents at grade crossings are due to the carelessness of the small minority of 3 per cent is the conclusion drawn by the Pennsylvania R. R. after a check at numerous crossings in several states during the four summer months of 1923. Of 242,142 cars checked only 7,566 had reckless drivers. This recklessness was displayed in neglecting to look out for trains, disregarding engine whistles and the stop signals of watchmen, excessive speed, stopping and turning cars on the tracks, driving under gates which were being lowered and racing across the tracks to beat trains.

Building 1,000 Miles of Paved Road in One Season

Illinois for the Past Two Years Has Broken All Previous Records in Constructing Hard Surfaced Roads —In 1922, 741 Miles, in 1923, 1,024 Miles—How?

By C. M. Hathaway
Engineer of Construction, Illinois State Division of Highways, Springfield, Ill.

OVER a thousand miles, precisely 1,024 miles, of paved state road were constructed in Illinois in the working season of 1923. This is the greatest mileage of paved road ever built in one year by any state highway department. The physical immensity of the task equals that of many of the more spectacular civil engineering works of the world, the construction period of which aggregated some years instead of some months less than one year. What has made the accomplishment possible?

Due to a rather large program during past years the organization of the Illinois Division of Highways has gradually increased in numbers and in men of experience. Therefore, the operations of 1923 required only the expansion of an organization which already existed and which has been schooled by past years' performance in design and location, in methods of construction, and in details of inspection. For the same reason there were also available contractors familiar with state road building, who have from past experience become specialists in paving, grading or bridge work. Without both of these organizations, developed through time and thoroughly experienced, it is certain that such a program as that of 1923 could not have been contemplated—much less completed.

Essential Requirements

1. Funds must be available for immediate payment for work as completed.

2. Let contracts before Jan. 1 of the construction year.

3. Store aggregates and cement so that the construction season, insofar as these commodities are concerned, is spread over ten months rather than six or seven months, as previously.

4. Spread the construction program over the whole state in order to embrace as many railroad systems as possible, and refrain, as far as possible, from concentrating shipments over one railroad system.

5. Utilize all available sources of aggregates and develop additional supplies when possible.

6. Let sections of suitable length to give the contractor a full season's work, and yet not so long as to make completion questionable.

7. Develop contractors of experience in road construction and encourage successful contractors.

8. Complete heavy grading and large bridges at least a year in advance of paving.

9. Hold frequent interviews or conferences with contractors to obtain their view point and, in turn, make plain the policies of the highway division—this to be done by either the Bureau Chief or District Engineer.

10. Build up a well developed and thoroughly responsible organization of engineers, operating in such a manner as to insure the specifications being thoroughly adhered to and at the same time giving the contractors such co-operation as is necessary for economical and efficient operation.

11. Have a complete understanding of all details of the particular job before the contract is signed. Settle on an agreed "progress" to be carefully checked and promptly remedy any delinquency.

12. Make sure of the ability of the engineer in charge, or district engineer, to handle all questionable details of construction without delay, and his co-operation in making frequent payments to contractors in order that the latter may not be embarrassed for funds.

Let us review the figures. There were constructed in 1923 in the period indicated by the progress chart, 1,071 miles of road of which 1,012 miles were portland cement concrete, 12 miles brick and 47 miles gravel. In addition, there were completed 2,649,700 cu.yd. of earthwork in heavy grading contracts and 48,726 cu.yd. of reinforced concrete in independent bridge contracts.

Practices Responsible—From experience Illinois has learned that the only system whereby a full season's work can be accomplished is to award road contracts early in the fall for the following year's completion. From August, 1922, lettings were held at intervals until January so that by Feb. 1, 1923, there was under contract approximately 75 per cent of the paving work which it was planned to construct during 1923, and also the bulk of the heavy grading and independent bridge work. The average "letting" comprises 100 to 150 miles of paving work and contracts were set from one month to six weeks apart. Thus the unsuccessful contractor is ensured the opportunity of bidding at the next letting, and is not encouraged to bid on more work than he can handle at any one letting.

To admit the small contractor and insure completion in one season the average length of a paving section has been established as 5 to 7 miles, but combinations of two or three sections are frequently offered and awarded when the contractor can demonstrate his ability to handle such a combination. As a matter of fact, 1922 and 1923 performance has demonstrated either the adoption of a 10 mile section or the feasibility of awarding two average length sections to a reputable contractor, which latter course is now a common practice.

A program of construction concentrated on a few through routes in 1919 and 1920 demonstrated very forcibly to the department the inadequacy of any one railroad system to handle a large road-building program; also the inadequacy of localized aggregate supplies, for which reasons it was realized that in order to complete 1,000 miles of pavement it would be necessary to have this mileage scattered throughout the state in suitable sections, thereby utilizing as many as possible of the railroad lines in the state, and all the available aggregate deposits of the state and adjacent states. In addition, traffic records show that there is usually a car shortage beginning about Sept. 1, and inasmuch as the construction season in Illinois extends from about May 1 to Dec. 1 it is apparent that for at least three months out of the seven a railroad car shortage may be anticipated. Experience has also demonstrated that the cement companies have been unable to ship, during a

seven-months' period, sufficient cement for such a large mileage as was completed in 1923, since the demand for this cement comes at a time when shipments to dealers and other projects are also at the peak. Hence, it was decided to spread out the storage of aggregates and cement over a nine to ten months' period instead of a period from May 1 to Nov. 1.

By storing 1,000,000 bbl., or about one-third of the cement required for the 1923 program, before May 1, the cement companies were able and glad to ship this amount during a slack period, and so during the balance of the season were able to keep up final shipments in a satisfactory manner. The same was true of the aggregate companies. Consequently, before starting work in 1923 every forehanded contractor had in storage an amount of coarse and fine aggregate ranging from 25 to 50 per cent of his total requirements and at least one-third of his cement. A careful check on cement storage has shown that of cement properly stored during

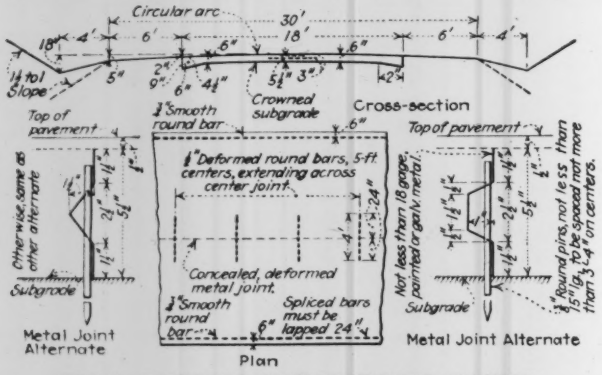


FIG. 1—STANDARD CONCRETE ROAD, ILLINOIS DIVISION OF HIGHWAYS

January, February and March and held until August or September, the resulting loss due to caking, dampness and rehandling was actually 0.61 per cent. Storage can be maintained for 15 to 20c. per barrel, including all rehandling. This storage of cement is anticipated in the contract, and in making estimates storage is figured. Recognizing the importance of the storage of materials the highway department has, as a special inducement, adopted the policy of allowing payment to contractors for all aggregates placed in storage upon receipt of satisfactory assurance that the materials are received, paid for, and stored in a manner satisfactory to the engineers of the department. Thus a contractor can afford to place in storage several thousand dollars' worth of aggregates and still not impair his working capital materially.

By awarding contracts early in the fall the state is able to get a selection of the best contractors before they secure jobs in other localities. This is distinctly to the advantage of the contractor, since he knows exactly his program for the coming season. He can make his storage arrangements and plan his set-ups accordingly, and thus take advantage of a full working season.

Another feature which has assisted in the large mileage of pavement constructed is the policy of putting under contract heavy grading and bridge work one to two years prior to pavement construction. This is conducive to a better roadway, greater performance and reduced cost: (1) since the fills may uniformly settle and thereby avoid future settlement, which must necessarily result where pavements are placed on fresh fills; (2) since the contractor does not waste a month to six weeks of good paving weather while the grading and culvert work is progressing; and (3) because the grading man and the bridge man, each with his own special equipment, are necessarily in better shape to do better and faster work, and at a less unit price cost.

The above features have been demonstrated in Illinois by past years' experience and explain some of the features governing design, also how it is possible to crowd as large a construction program into seven months as has been done during the past season, which will be continued.

Let it be added that the engineering staff of the state of Illinois has grown up with the organization—its heads through years of experience and absolutely unhampered by "turnovers" due to changing state policies; its assistants by similar experience and recognition of ability; and its younger engineers and inspectors by careful selection and their ability to handle their part of the work in an acceptable manner. It is no one year's development, but an organization having its beginning with the creation of a Highway Commission as early as 1906 and still made up in part of the old personnel.

Methods and Performance—It is hardly within the scope of this article to outline in detail all the different types of equipment and organizations of the numerous contractors, but it is of interest to note that they are not following out a blind guess in the organization and operation of paving outfits, but are following certain distinct lines and processes which were not noticeable a few years ago. Each contractor has studied plant layout, hauling equipment, mixing and placing, and although there is rarely seen the same identical equipment on any two construction jobs, yet in a general way there will be found a marked similarity in the main features. It is undoubtedly no mis-statement to say that the mileage constructed in 1923 could not have been completed if the department had not had the benefit of several years of active construction work during which

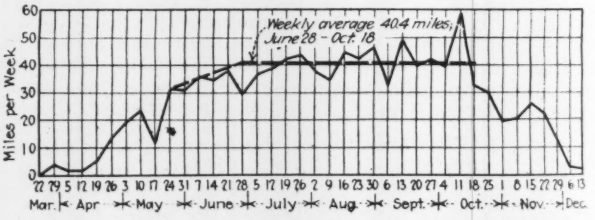


FIG. 2—WEEKLY PROGRESS IN ROAD CONSTRUCTION IN 1923

time the contractors were "finding themselves" and working up organizations for maximum efficiency.

Until 1921 a yearly output of 4 to 6 miles was an average season's work. On all jobs (irrespective of type of outfit) in 1922 the average weekly output per outfit was 0.33 miles per week and 410 ft. per day; and although final 1923 figures are not yet available, it is almost certain that they will be at least equal. Eight to twelve miles is now the average paving contractor's yearly estimate of performance and fifteen miles for a 21-E paver is not unusual. The weekly "high daily run" in each of the mine districts reported for a period of nine weeks shows a grand average of 826 ft. for a 21-E paver. Similarly, the high weekly average reported for nine weeks shows a grand average of 3507 ft. for a 21-E paver.

Records for 1923 performance by individual contractors are as follows:

1—51.19 miles with 5 outfits
2—49.18 miles with 4 outfits
3—40.32 miles with 3 outfits
4—30.90 miles with 4 outfits
5—28.90 miles with 2 outfits

The high records with a single outfit are as follows:

1—17.55 miles with a 32-E Paver
2—18.14 miles with a 21-E Paver
3—15.50 miles with a 21-E Paver
4—14.95 miles with a 21-E Paver
5—14.80 miles with a 21-E Paver
6—14.17 miles with a 21-E Paver

An analysis of all paving jobs in the state during 1923 brings out the same outstanding feature that was evident in 1922—the average contractor is using a 21-E paver as the ideal mixer to put out a satisfactory amount of concrete per day; and the same analysis indicates that the other units in the contractor's oufit are designed to fit the paver. It is generally admitted that if sufficient material can be delivered to a 21-E paver to keep it in full operation, it will turn out enough square yardage of pavement daily to satisfy the average contractor's requirements to the end of a profitable job.

Transportation—The field at present seems to be more or less evenly divided between truck haul and industrial rail haul. The use of the latter has been somewhat restricted in the past due to the fact that it has been commonly supposed that the industrial outfit cannot be used to good advantage on the heavy grades, but the past two years have demonstrated more and more a tendency on the part of contractors to use the industrial equipment—and successfully—on grades. Insofar as the truck is concerned, indications point to a preference for light trucks; as a matter of fact, the lighter truck is advocated by the department on account of the disastrous effects of the heavy truck on Illinois natural soils and on the subgrade.

Specifications largely govern the actual equipment in connection with placing the concrete and finishing the pavement. Therefore, it will be unnecessary to dwell in detail upon this feature.

Construction—Some outstanding features of 1923 construction are: the successful application of pavement cross-section as evolved from the results of the Bates road experiments, featuring the thickened edge, center joint, and longitudinal rods (Fig. 1); the satisfactory use of calcium chloride in curing; use of a subgrade machine to insure a full thickness of pavement; new developments in finishing machines; a pavement smoothness to meet the requirements of "no variation over ¾ in. in surface"; the minimum radii of 500 ft. on all 90-deg. curves; and the development of a detour marking system.

A glance at Fig. 2 will show the weekly progress of construction during the season of 1923. It may be seen that there are numerous fluctuations, yet if an "average line" is assumed, as shown, it will be noted that there is a very uniform rate of progress throughout the period from June 28 to Oct. 18, and fluctuations can usually be explained by holidays or by rainy weather.

There may be some question in the mind of the reader how so large a program of construction can be undertaken and completed by contract without more failures or delinquencies. It can be safely stated that Illinois has thus far escaped disastrous failures on the part of contractors and in general has not encountered the type of contractor who does not desire to give a dollar's worth of work for a dollar's worth of reimbursement. Contractors are regarded as honorable parties of the contract and as men who desire to co-operate as thoroughly with the specifications as the engineers require. Of course, it must not be construed that there are not occasional and frequent differences of opinion between engineers and contractors, but, taken as a whole, it is of extreme interest to note that the relationship between engineer and contractor in Illinois is excellent. On fully 75 per cent of the jobs the contractors are men who have done work in Illinois before, and who are familiar with the requirements of the department, and appreciate that the engineers "know their business" and will insist upon proper construction and that they cannot be induced to accept anything else.

Before awarded contracts for any work, the successful bidder is called into the main office and the entire proposition is gone over thoroughly to get his viewpoint as to organization and progress; and it is after these points are agreed upon that the contract is awarded. Immediately the contract is awarded the contractor is watched carefully to see that his organization and progress correspond to that promised, and at the first indication of any slackening up of the work he is called into conference and admonished to strengthen his organization to produce the required weekly output agreed upon.

The Department, on its part, appreciates the necessity of the contractor receiving prompt and frequent payments, for which reason progress estimates are made every two weeks if so desired, and in addition, payments for material in storage are allowed as elsewhere referred to.

Engineering Enrollment Has Little Change

THE PREDICTED falling off in the attendance of engineering schools during the year 1923-1924 has been very small, according to the preliminary report of the U. S. Commissioner of Education covering statistics from 68 of the 130 engineering schools in the country. The report classifies the schools according to attendance—over 500 and under 500—and although individual schools in each group show some increase or decrease, in no case more than 20 per cent over last year, the totals for the two years are surprisingly similar; 11,078 as against 11,065 for the small schools last year, and 21,122 as against 21,374 for the large schools.

The average attendance per school for the last four school years is as follows:

	1923–4	1922–3	1921–2	1920–
Large schools	1,005.8	1,017.8	1,103.7	1,102 6
Small schools	235.7	235.4	228.5	208.7

This shows a decrease in the large schools over the post-war years and an increase in the small schools.

Only a few schools show any notable progressive decrease in attendance. They are the University of Michigan, Case School of Applied Science, Stevens Institute of Technology, the University of Washington, and possibly Cornell University, although the latter has shown a very slight increase this year.

The number of post-graduate students shows considerable falling off, this year's figure being 612, as compared with 725 last year, but no falling off as compared with 1921. It is interesting to note that 227 are at Massachusetts Institute of Technology.

Imhoff Tank Operating Procedure

Abstract of Paper by Earle L. Waterman, Associate Professor of Sanitary Engineering, University of Iowa, Presented to the Fifth Conference on Sewage Treatment at Ames, Iowa. There are 61 Imhoff tanks in Iowa, alone, Prof. Waterman stated.

IF IMHOFF tanks are to give an effluent comparatively free from suspended solids and the products of sludge digestion and are to produce a sludge which is free from disagreeable odors and will dry readily, careful and systematic operation of the tank is necessary. Experience has shown that attention should be given to the following schedule of operation:

Cleaning Screens and Grit Chambers—The coarse screens should be cleaned daily and the screenings buried. Grit chambers should be cleaned after every heavy rain.

Cleaning Sides and Bottom of the Settling Chamber—Once every week the sides and bottom of the settling chamber should be cleaned. Very frequently growths attach themselves to these surfaces and serve as miniature catch basins for the settling solids. Unless they are removed undesirable septic action may be started in the settling chamber. This cleaning should be done with a squeegee (a hard wood board 12 to 15 in. long and 3 to 4 in. wide having rubber edges and attached to a handle which is of sufficient length to reach down to the slots in the bottom of the sedimentation chamber).

Removing Floating Material from the Sedimentation Chamber—Material which floats on the surface of the sedimentation chamber, such as grease, matches and corks, sometimes scum, should be removed with a skimmer and placed in the gas-vent chamber. If this is not done septic action may set in. A very satisfactory skimmer may be made from woven wire having about ten meshes to the inch. A hoop of ¼-in. iron rod is attached to a long wooden handle, then the woven wire is bound to the hoop in such a way as to form a dish-shaped skimmer.

Equalizing the Deposit of Sludge—If the construction of the tank permits it is advisable to reverse the direction of flow through the sedimentation chamber every month.

Treatment of Scum in the Gas-Vent Chambers—The scum which forms on the surface of the liquid in the gas-vent chambers should be broken up at least once a day. This matter of keeping the gas vents functioning properly seems to require more attention on the part of the operator than any other single phase of Imhoff tank operation.

Observing Depth of Sludge—It is important to know the depth of sludge in the sludge compartment. Observations to determine this depth should be made at least once a week. If the sludge compartment is divided into two or more pockets the depth of sludge should be determined in each pocket. This may be done by means of a sheet-iron plate 12 to 18 in. square attached to a wire or cord or long light wooden rod in such a manner that it will sink in a horizontal position. When it reaches the top of the sludge the rate of sinking will be checked and at this point the depth should be observed. This observation can generally be made through the gas-vent chambers.

Drawing Sludge—In a normally operating Imhoff tank, sludge should be drawn when the sludge compartment is filled to within 20 in. of the slots. The valves in the sludge outlet pipes should be opened very slowly. As the sludge begins to flow freely, close the valve, let it remain closed for two or three minutes and then slowly open it again. By doing this a chance is given for the heavy sludge in the bottom of the sludge pockets to start moving toward the sludge pipe. Quick opening of the valves may result in drawing sludge from the top instead of the bottom of the compartments. It is the bottom sludge that should be removed. If there is water supplied to a perforated pipe near the bottom of the sludge compartment the valve controlling it should be opened just before sludge is to be drawn.

There is danger of drawing too much sludge at one time. A certain amount of digested sludge should be left in the tank to seed the sludge compartments. Otherwise the process of sludge digestion will be temporarily retarded each time the sludge is drawn. No fixed rule for determining the proper amount of sludge to draw at one time can be given. It is the writer's practice to close the sludge valve when the outflowing sludge begins to change from a black to a gray color. However, this rule probably is not applicable to all tanks and each operator must learn from experience when to stop drawing the sludge.

In addition to drawing sludge when the sludge compartment is nearly filled it is often advisable to draw the sludge in small amounts when there is any evidence of "foaming" in the gas vents. The writer believes that it is better policy to draw small quantities of sludge frequently rather than large amounts at long intervals.

Drying Sludge—A well drained sludge-drying bed is a necessary accessory to an Imhoff tank. It is not advisable to cover the bed to a depth greater than 12 in. In from ten days to two weeks after it is applied to the sludge bed (during fair weather) the sludge should dry enough to be easily removed with hoes and shovels. This removal should be done promptly so that the bed may be ready for the next dose of sludge. In some cases the drying of the sludge may be hastened by mixing a solution of alum with the sludge just before it enters the drying bed.

Structural Teachings of the Oppau Explosion

BY DR. E. G. FRIEDRICH
Berlin, Germany

SOME important teachings concerning the behavior of structural elements and structures were derived from a study of the wreckage of the Oppau ammonia plant after the great explosion of Sept. 21, 1921. A summary of certain of these teachings has recently been published by H. Goebel and E. Probst in book form.

Even prior to the Oppau accident, it was considered good practice to build structures for the manufacture or storage of explosives with light roof construction and strong sides and floors. From the Oppau effects it is learned that in addition the roof should be so designed that its parts will not have projectile action. Cinder-concrete roofs behaved especially well. With regard to resistance against penetration of falling material, roofs of reinforced concrete and of hollow tile made a good showing, while brick and timber roofs proved undesirable. Framed structures with wooden roofs suffered very extensive injury, generally by the air pressure lifting off the roof, after the windows and wall panels were blown in.

KINKING OF ROD REINFORCEMENT

Side walls strengthened by piers or buttresses or by earth embankments showed increased resistance.

STACK CONNECTING FLUE AT OPPAU

Curved wall uninjured while flat walls close by were crushed in. Flue torn away from main flue by breaking its columns at base and cap. Repair of this flue was accomplished simply by jacking it back to position and jacketing the columns.

Ground-floor pavement of reinforced concrete proved superior to unreinforced concrete.

Careful isolation of machinery foundations proved its value. Most of the machines at Oppau had been well isolated to reduce tremor effects, and the result was that the larger part of the machinery survived the destruction of the buildings.

Structures with curved exterior walls showed better resistance than buildings of rectangular plan, probably because the curved walls deflected the pressure wave.

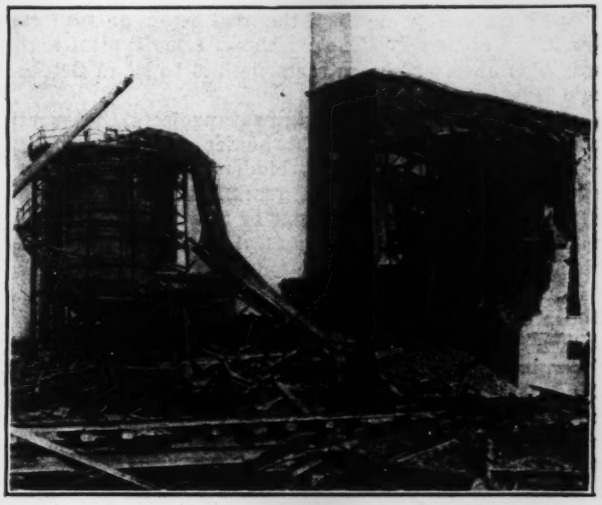
With regard to facility of repair and reconstruction, reinforced concrete was found superior to steel construction. Restoration of reinforced-concrete structures even after heavy damage was relatively simple, while the damaged steel structures usually were so badly distorted that they had to be scrapped. An example of reinforced-concrete restoration is the case of the boiler smoke flue, comprising the flue proper and two curved junction flues leading to the stack. Each of these junction flues was supported on six reinforced columns 28 in. square by 30 ft. high. The explosion cracked and broke the columns near base and cap, and separated the curved portion of the flue from the main flue by a 30-in. gap. After first carefully shoring the structure it was possible to jack it back to position and close the gap at the connection to the main flue, after which the columns were jacketed with a reinforced-concrete envelope.

Construction joints in concrete were shown to be points of shear weakness, indicating that such joints should be offset and toothed.

Peculiar distortion of reinforcing rods was observed extensively. The tremendous impact tore the steel bars out of the concrete and kinked them as if from the spring following upon release of their stress. Detailed examination showed that the bars had not developed cracks, but a change in the structure of the steel was found to have occurred which suggested that the distortion had taken place in a heated condition of the metal. These bars were scrapped.

Steel-frame constructions were wrecked or badly distorted. Even the steel frame of a building under construction, which exposed very little surface to the attack of the explosive wave, suffered distortion. Quite generally the damaged steelwork was scrapped, but the necessity of doing this seems questionable. Most of the steel might have been straightened and re-used. The plant management decided against using the steel because it exhibited strain lines, indicating that the material had been stressed above its yield point. Several recent investigations of distorted structural steel indicate, however, that the material could have been re-used safely, as tests of such material have shown no loss of strength or ductility.

Shearing of rivets was responsible for much of the injury to steel structures. One point deduced from the wreck is that two-rivet connections of lattice bars, especially in columns, are not adequate; shearing of these rivets was responsible for much of the distortion



DAMAGE TO STEEL-FRAME BUILDING

of the structures. Deformation of the flanges of wide-flanged sections also occurred very extensively, which suggests that such sections should be used only when their flanges are properly stiffened.

Canada's Railway Financial Condition Improves

According to a statement by the Dominion Bureau of Statistics, the Canadian National Railways during the nine months ending with September had a net operating revenue of $6,857,815, as compared with $527,313 for the corresponding period of 1922. The Canadian lines accounted for $73,780, as compared with a deficit of $3,247,210 last year. The lines in the United States earned a net revenue of $6,784,035, as compared with $3,774,533 for the nine months period of 1922. The Canadian Pacific Railway's net operating revenues for the first nine months of the year were $17,858,896, compared with $19,435,331 for the corresponding period of last year.

Are Surety Bond Premium Rates High?

By R. H. Towner
and H. H. Wilson

Rating Bureau Official and Prominent Contractor Discuss Bonding Practice in Highway Construction

Bonding practice is of vital concern to state highway departments and to contractors for road construction. With a billion-dollar highway improvement program annually, the expense to the people for surety bond premiums is an astounding sum. Whatever can be done to reduce its amount should be done. The question of practice goes deeper than premium rates, however. It touches on contractors' responsibility, the fostering of incapable contractors and the constraint of engineering independence in directing work. It has become an irritant in the body of highway affairs which are concerning the people so widely. There must be determination and correction of these conditions, and frank discussion is a preliminary step. There is plain speaking in the discussions which follow and it will not be evaded in other discussions to come.—Editor.

The Case for the Surety Company

By R. H. Towner
Towner Rating Bureau, New York, N. Y.

An EDITORIAL in *Engineering News-Record*, Nov. 8, 1923, p. 748, declares that "a rate of 1½ per cent on the contract price is an absurd charge for the public to pay for safety against the real risks of highway work." Let us see. Table I shows some typical highway bids upon which contracts were to be let in October and November of last year.

On every one of these highway projects the surety eventually bonds the lowest bidder who can qualify (not necessarily the lowest bidder when the bids are opened). The surety bond guarantees the completion of the contract for the amount of this bid and the payment for all the labor and materials which go into the work. Guaranteeing completion by the lowest qualified bidder means that the surety guarantees a saving to the state at least equal to the difference between his bidder's figures and those of the next lowest bidder. Now, let us suppose that in the above lettings the lowest bidder qualifies and, for a premium of 1½ per cent, furnishes a surety bond guaranteeing to complete the work. Table II shows what the state saves and what the surety gets at each letting.

These are not picked cases, but are highway lettings as they commonly occur. The surety's premium is a little more than 10 per cent of the amount which the state saves by getting the lowest bidder guaranteed.

As for the surety's losses being due to "unwise risks which are constantly being taken in the strife for business," the reply is that letting contracts to the lowest bidder always forces the worst risk upon the surety company. The highest bidders would be the best risks; the average bidders the average risks; but the lowest bidder is always the worst risk. Yet, it is this risk that the surety must always take if it is to underwrite any contract bonds at all. Contract bonding is the only form of underwriting in the world where the underwriter instead of being allowed to select risks that are average or better than average, must always and everywhere accept risks that are below average, on a selection that has already been made for him. Notice in Column C, Table I, that three bidders are close together at $250,000 to $254,000 each. But the average of the other three bidders is $189,097. If the surety for the three lower bidders had the advantage of the average price of their three bids (instead of taking the lowest of the three) it would still have to guarantee the completion of this work for a sum $63,000 lower than the other three bidders on it had estimated that it would cost. (The lowest bidder on that project—nearly $100,000 below the average of the other five bidders—is said to be a member of the Associated General Contractors.)

Complaints of the present premium rates for the contract bonds of surety companies have no foundation in

TABLE I—TYPICAL HIGHWAY BIDS SHOWING RANGE

A	B	C	D	E	F
$273,345	$327,792	$144,606	$11,534	$204,818	$155,948
300,206	355,635	197,576	146,733	222,859	159,493
363,985	389,025	225,111	.....	230,683	175,602
.....	397,420	252,260	.....	238,635	.....
.....	.....	253,683	.....	245,468	.....
.....	.....	254,107	.....	266,430	.....

fact, in figures, or in experience. They seem to spring not from a study of the problems involved but, if I may say so, from the mere practice of nagging at surety companies, which has grown into a habit among some contractors, highway engineers and their spokesmen. As a matter of fact, contract bonds are the most difficult to underwrite successfully of the entire field of insurance. The problems of fire underwriters, life underwriters and others are reasonably standardized and do not greatly differ from year to year. At the end of each year, moreover, they know all the fire losses and all the death losses that have occurred during the past twelve months. They have to deal only with the uncertainties of the year to come. The problems of contract underwriters are continuously changing, and in that field every successful underwriter must be vigilant and alive to see changing factors which may not only affect the experience on bonds to be underwritten in the coming year, but may expose to enormous losses contract bonds that he has already underwritten in the year that has passed. The premium rates of twenty-five years ago referred to in the editorial covered a period when this country had unrestricted immigration, so that unskilled labor was continuously being imported from Europe. That day has gone by. Immigration is restrained and labor in this country, with the facilities of travel and the activities of labor agents, is continually shifting, continually exacting higher wages, and continually affecting the underwriting conditions surrounding every contract that is written for a fixed price.

Eighteen months ago the city of Hartford, Conn., let a high school contract to a very responsible contractor for $1,270,000. A few weeks ago an exact duplicate, with the same architect, etc., was bid upon and the contractor who is just now finishing the first one, was

the low bidder at a price about $300,000 over the price he bid eighteen months ago. The surety on building contracts, as on highway contracts, receives a premium of 1½ per cent for twenty-four months; and this premium guarantees all the changes in labor conditions and other expenses and underwriting problems which may affect the contractor in that period. But, as shown

TABLE II—SAVING DUE TO BONDING LOWEST BIDDER

Project	The State Saves	The Surety's Premium
A	$26,861	$4,100.17
B	27,843	4,916.88
C	52,970	2,169.09
D	35,199	1,673.01
E	18,041	3,072.27
F	3,545	2,334.22
	$164,459	$18,265.64

in this instance, the changes in costs between today and eighteen months ago amount to nearly 25 per cent of a contract which was let then. Yet, the surety has received but 1½ per cent for underwriting the ultimate burden of a change of nearly 25 per cent. Instead of perpetually nagging at surety companies, architects and engineers ought to express their unfeigned admiration at the success with which a body of skilled underwriters, in active competition with each other, manage to keep going and distribute losses at premium rates which are so far below the actual and demonstrated hazards of the risks which they must assume.

* * *

The Case for the Contractor

By H. H. Wilson

Managing Partner, Winston & Co., Contractors, Muncy, Pa.

IT IS to be regretted that Mr. Towner's viewpoint is so close to one side of his subject that he is incapable of crediting architects, constructors and engineers, holding conflicting opinions, with anything save an attitude of "nagging."

Mr. Towner's article is chiefly an explanation and justification of the mathematics of underwriting as now practiced. This is not of interest to the public, which recognizes no obligation to guarantee the mechanism of business or the solvency of corporations, under a condition where a closed market has been made and all competition stifled except possibly in the premiums paid to agents. The public generally enjoys some measure of competition in the cost of everything entering into road construction except surety company bonds. These reflect a fixed cost and the same rate for any and all conditions. Mr. Towner states that "letting contracts to the lowest bidder always forces the worst risk upon the surety companies." Is not the use of the phrase "forces the worst risk" unjustified? Is it not true that no public official will award a contract to the "worst risk" until some surety company has guaranteed it and that escape always lies in the hands of the underwriters?

The following extract from a recent report of the Joint Committee of the American Association of State Highway Officials and the Associated General Contractors of America is particularly pertinent to the alleged helplessness of surety companies regarding the worst risk:

> To the layman, unfamiliar with the difficulties involved where a highway department is attempting to carry out a definite mileage on schedule, a financially strong surety is regarded as ample safeguard to the state. In view, however, of the delay and legal procedure frequently incurred by default, a corporate bond has often proven an inadequate and expensive form of protection. Some means is needed for minimizing the operations of irresponsible contractors and for encouraging the growth of more responsible concerns. Most highway departments now have authority to reject the bid of an irresponsible company; but, in practical effect, such authority can seldom be freely exercised. As long as irresponsible bidders can secure bonds, and the public is willing to accept those bonds as a guarantee of responsibility, the highway officials will not be in a position to exercise their rightful authority. . . . *They cannot judiciously refuse in many instances to award a contract to an incapable contractor while this practice* of *promiscuous bonding continues.* The present system is one which appears to have passed in a great measure beyond the control of bonding company officials and to have resulted primarily from the commission system of compensating underwriting agents. . . ."

Mr. Towner cites figures to show the saving in having the "worst risk" guaranteed. He makes no attempt to evaluate the loss which so often results from administrative and engineering expense on contracts being vastly increased through the bonding of constructors without necessary capital, experience or equivalent with which to complete their undertakings at all or within the time specified. He also ignores the public expense of inconvenience, time and transportation costs by being deprived of the use of improved thoroughfares and from defective work. As a specific instance, it would be interesting to have Mr. Towner evaluate the expense to Ohio taxpayers last year in being forced to carry into 1924 over seventeen million dollars of uncompleted highway construction, also the cost of unsatisfactory work resulting from the bonding of irresponsible constructors. It would likewise be illuminating to have figures regarding the expense of litigation incurred by states, private owners, vendors and others, in proving their claims for payment under corporate bonds. Mr. Towner's justification for an increase of more than 1,000 per cent in contract bond premiums, in twenty years, appears to be based upon the labor question. While this is a factor which has increased the hazard on public construction work, it falls hopelessly short of accounting for such an increase as the foregoing percentage. It is, furthermore, reported that the percentage of premiums paid to agents generally have been more than doubled in the past 15 years, indicating a cash value for commissions more than twenty times greater than twenty-five years ago.

Another quotation from the previously referred to report of highway engineers and constructors is in order here:

> Agents are reported as receiving commissions amounting to as much as 30 to 50 per cent of the total premium. Local competition between agents of different underwriters is keen. Their primary interest appears to be often manifested chiefly in securing a bond for the lowest bidder, not because he is competent but merely to secure the compensation involved. This situation could not occur in a truly competitive industry, where the demand for a commodity is influenced by the prices charged. In the public bonding field, because of urgent demand, work will proceed almost independently of a bond premium rate, and because of a standard charge by all underwriters it has been possible to increase the rate to a point where such increases mean millions of dollars annually to the public, but have not increased the net earnings of the bonding companies in proportion.

In a recent letter to the Massachusetts Department of Public Works, Ransome Rowe, President of the New England Road Builders Association, stated that if the Towner Rating Bureau were called upon to furnish

the premium and loss figures of the bonding companies on state highway work in Massachusetts, during the past twenty-five years, he believed it would be disclosed that the amount paid by that Commonwealth indirectly in premiums would be found to be enormous and the losses to the surety companies negligible. He also stated: "We are certain no justification could be found in such figures for the present 1½ per cent rates. Experience shows that a surety company's bond is not all that it seems on its face and that in instances where the risk the company is paid to assume turns out to be a real risk and a loss must be paid, it is not met with good grace, but, on the contrary, loop-holes of possible escape or delay are sought and availed of." Mr. Rowe also cites the case of a vendor who was forced to bring legal action to prove his claim under a surety company bond, and this vendor is quoted as saying that it was not so much the money involved as the principle of the thing which bothered him.

None of those whom Mr. Towner accuses of "small practice" would desire to deny the surety companies the right to exist and do business, so long as their conduct is in consonance with private and public welfare. Almost any student of political economy will, however, admit that, when a constructor can be put into the penitentiary for accepting a bond at less than the rate fixed by Mr. Towner's Rating Bureau, the law is being used for the support of special interests in a manner not contemplated by the framers of any constitution.

The question which the surety companies must face, and which the public will, eventually, force them to face, is not the necessity for rates to safeguard existing practices, but the necessity for making rates to meet competition from other forms of suretyship which have been devised and used in various sections of the country with marked reaction on costs.

Notwithstanding Mr. Towner's concluding bid for the admiration of those whom he belittles, there are many earnest and fair-minded men in these professions and elsewhere who are convinced that the 1½ per cent premium is high enough to permit the taking of wild chances by the less responsible surety companies and still leave sufficient dividends to satisfy stockholders. If so, a reduction in the rate, by whatever means secured, should tend to eliminate both the irresponsible constructor and the reckless underwriter.

Shall we accept the contentions of the surety companies as to deceptive financial statements from constructors, agents, etc., as an excuse for failure to find means to circumvent those contingencies? Do not such pleas suggest that those corporations, in the strife for growth and business, have allowed too much latitude to their clients and agents in credence and commissions, that they have signally failed to develop a sound system of investigation? Can it be that the evils with which they now have to contend result from the rivalries of agents for the tremendous commissions paid which appears to be the only form of competition existing since the adoption of a standard rate card? If, as Mr. Towner alleges, the underwriters are forced to take the "worst risk" and if a great industry and the public are being damaged thereby, is it not clearly obligatory upon them to work out some solution of the matter?

In conclusion, it is believed that a long suffering industry and public will not forever accept a closed market, assuring premiums commensurate with imprudent practice, but will eventually demand that corporate underwriters either conduct their business in accordance with sound system or else allow the field of contract bonding to be covered by other methods which will allow free play of natural economic laws. Competition is the life of business. It often offers a solution for problems which, otherwise, appear hopeless. Further, concerning the concluding paragraph of Mr. Towner's article, it is opportune to say that many architects, engineers and constructors have expressed their "unfeigned admiration" at the manner in which surety companies are reported to have been able to influence legislation in many states in the direction of specifying a surety company bond to the exclusion of all other methods of suretyship.

Tar Surface Treatments Preserve Gravel Roads

Economical Where Traffic Exceeds 300 Vehicles —Method of Application Important— Careful Maintenance Vital

By J. T. Donaghey
Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

Of the present 10,000-mile state trunk highway system in Wisconsin 4,500 miles have a gravel surface. Probably 1,500 miles of the gravel roads carry an average daily traffic in excess of 300 vehicles. Then it becomes necessary to protect the surface. The most satisfactory results have been obtained by the use of light tar surface treatments. Where the daily traffic does not exceed an average of 300 vehicles, it is generally cheaper to maintain a gravel road by adding the proper amount of new material annually, which is estimated to be 300 cu.yd. per mile on a 20-ft. surface. Where the daily traffic ranges from 300 to 3,000 vehicles per day, resulting in an average for the summer season of 1,000 per day, the cost of a tar surface treatment is justified.

Where traffic reaches an average of 800 to 1,000 vehicles per day, the loss is not less than 1½ in. of surface annually, or not less than 400 cu.yd. per mile. Very few localities have enough gravel available to construct and maintain their roads for ten years unless such material is conserved to the very maximum limit. A loss of 400 cu.yd. annually would in five years provide sufficient material for a mile of new road. No community can afford this loss.

Material Used—No material is used in the top 5 in. of a gravel road surface which exceeds a size that will pass a 1-in. round opening. This material is not separated, but is all deposited in the same bin and loaded into the trucks from a chute in the bottom of the bin. This insures a uniform gradation. The same specifications prevail on all resurfacing of old gravel roads. This costs somewhat more than pit run gravel or gravel crushed to a larger size, but it is worth much more than the difference in such cost, especially where the surface must be scarified frequently.

Preparation for First Treatment—The surface is thoroughly scarified to a width of 20 ft. and to a depth of the deepest holes appearing in the surface, which is generally not more than 2 in. It is necessary to lap the scarifier one-half in order to get the surface completely scarified, as material of this kind becomes extremely solid under traffic and a once-over with the best of scarifiers will not produce the results desired.

Immediately following the scarifier, the surface is shaped with a 12-ft. blade grader to a uniform cross-section. The material is sometimes loose and dusty on account of the fine content, and time is permitted to elapse until the surface becomes well compacted. A good heavy rain will aid materially. The surface is

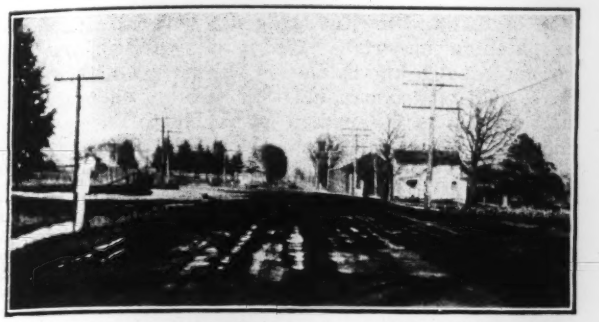


FIG. 1—SURFACE RUTTED DURING SPRING BREAK UP
White patches are water standing in holes and ruts. At this point the drainage was poor and the base gave way under traffic.

now swept clean with a rotary broom. The sweeper is hauled by a motor truck and leaves quite a windrow of dust and loose gravel—so that a light grader is used to push the windrow out of the way of the sweeper for its second trip. The surface is swept twice, and after the second sweeping the coarser gravel in the surface projects just a little above the rest of the surface, producing practically a mosaic surface. Should there be any dust pockets remaining, they must be cleaned out with hand brooms. Some gravel surfaces may not need scarifying and are shaped up very satisfactorily with a heavy blade grader.

Application of Priming Coat—After the surface is swept clean, the tar is applied as follows: Light tar equivalent to Tarvia B may be applied cold, but better results will be obtained if it is heated to 100 deg. F. The distributor should be thoroughly cleaned before beginning operations and then kept clean. There should be a double strainer on the distributor tank intake in order to exclude all cinders that may be in the tank car as it is almost impossible to secure a tank car of tar without having some cinders. It is also very necessary to have several extra nozzles so that if one becomes clogged it can be replaced immediately which will permit the distributor to operate evenly. Even distribution is very essential.

The priming coat is applied at the rate of ⅛ to ¼ gal. per square yard on new surface treatments, and no sand or covering is spread over it. Twenty-four to seventy-two hours are permitted to elapse after the priming coat has been applied, during which time traffic irons out the surface in a fairly uniform manner. If conditions will permit, immediately following the application of the priming coat the sand for covering the second coat should be deposited along the shoulder of the road. Be sure that the windrow of loose dust and gravel left by the sweeping has been pushed clear out over the shoulder with a grader before the sand is deposited along the shoulder as the sand piles should be on the shoulder outside of the edge of the surface-treated portion and not permitted to mix with the loose material swept off the surface.

Depositing Sand for Covering—Pea gravel, fine stone chips or clean sharp Torpedo sand is the best material to use for covering, and for a 20-ft. surface it will require about 50 cu.yd. per mile to cover the surface properly. The covering should be deposited in piles of about ¼ cu.yd. each, and 25 ft. apart, and care should be taken that the inside edge of the pile of sand be entirely clear of the outer edge of the surface treated portion for if a thin film of sand opposite the piles should be covered with the second application of tar it would pit out at that point and produce very unsatisfactory results.

The reason for depositing the sand in advance of the application of the second coat is that a certain amount of sand must be applied *immediately* after the second coat of tar touches the surface, which prevents the tar from running and permits it to penetrate the surface, thereby forming a skin coat and not a mat. The covering if deposited along the shoulder is also available to add immediately in any amount desired to prevent picking up and to cure bleeding.

Mechanical sand spreaders may be used, but if used, not to exceed one-fourth of the total covering required should be spread immediately following the distributor, an additional 50 per cent in about two hours, and the balance as needed to cure picking up or bleeding.

Application of Second Coat—Should several days have elapsed before the second coat is applied and the surface has become slightly loosened or dirty, it should again be swept lightly to remove any loose material. The distributor is now set to spread about ¼ gal. per square yard on a first surface treatment, and care must be taken to have the tar spread uniformly.

Before starting the distributor, a number of men

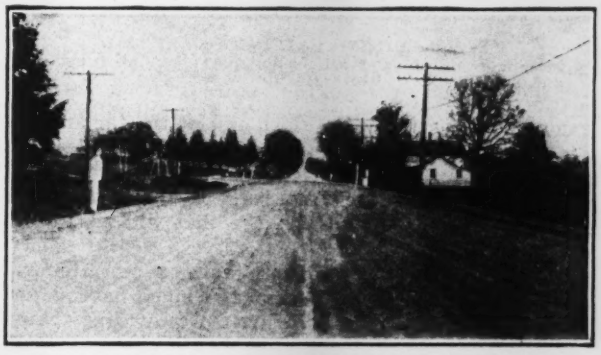


FIG. 2—SPRING BREAK UP DAMAGES REPAIRED
This is the same view as Fig. 1 after the road had been scarified, shaped and given a priming coat of tar.

(from 6 to 10) are stationed along the sand piles from 50 to 100 ft. apart. When the distributor is started along the road, the man at the first sand pile spreads a little less than one quarter of the sand in his first pile on the width covered by the distributor opposite the sand pile, doing the same with the next pile and so on, working rapidly. The second man does likewise when the distributor reaches a point opposite his first sand pile, and so on down the line of men. The first man, upon reaching the point where the second man started spreading, moves ahead of the line of men, beginning a new station the required distance from the last man in line. Handling the covering in this manner permits applying a small amount immediately after the tar touches the surface of the gravel, and, as stated before, prevents the tar from running off the road surface and permits it to penetrate the gravel, which is what is wanted. To do this part of the work cheaply

and rapidly, on a large mileage, there should be two distributors on each job, one being loaded while the other is distributing. There will naturally be a certain amount of time elapse between the loads, which permits the sand spreaders to go back and add sand where needed to keep the tar from running off the surface or to stop picking. The distance of the job from the supply of tar will, of course, enter into the question. The other side of the road is handled in just the same manner, and the distributor should be so equipped that two trips over the 20-ft. road will cover adequately the whole of the surface. If it is thought best to surface-treat wider than 20 ft. the distributor width must be extended correspondingly.

Extreme care must be taken to avoid spreading too much covering on the second coat until it has had time to penetrate the surface. If too heavy a covering is spread, or if the spreaders are careless and dump full shovels in a place, the result will be that the excessive

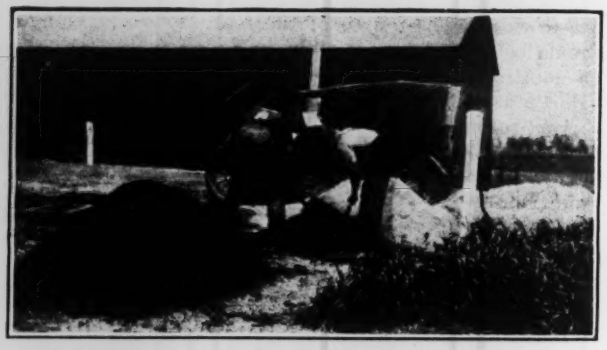


FIG. 3—MIXING PATCHING MATERIAL
A cubic yard of sand is mixed with 17 gal. of Tarvia B and light oil allowed to evaporate by storage.

amount of covering will absorb or blot the tar and prevent it from penetrating the surface and will result in a mat rather than a skin coat. The spreaders should use square point shovels and learn to throw the covering from the shovel in a manner that will produce an even application.

If the weather is reasonably warm penetration will immediately take place and after two hours have elapsed there is little danger in applying more covering than is necessary, as the tar will then have penetrated sufficiently so that the excessive covering will not blot the tar and form a mat rather than a skin coat. One or two extra men should be kept on each mile for at least a day or two following the second application to apply covering where the surface starts to pick up or bleed, and a small amount of material should be left in about every third pile for this purpose.

Patching the Surface—The patching material is composed of 17 gal. of light tar equivalent to Tarvia B, mixed thoroughly with 1 cu.yd. of torpedo sand. The material must be mixed thoroughly either by hand or in a mixer, and if it stands several weeks prior to being used after mixing, all the better. The oil evaporates and when thoroughly cured the mixture makes a better patch and will stay in place much better. Patching material mixed the previous year has been used with better results than when used fresh. No more than 17 gal. of tar per cubic yard of sand should be used even though it is slow in mixing.

Those in charge of maintenance must watch the surface very carefully, especially the first ten days after the surface treatment is applied. If a hole or abrasion appears in the surface the loose material should be swept out clean and the hole filled with patching material. If there are any places that appear loose and do not harden up under traffic, they should be dug out to a depth where solid material prevails, the hole filled and the material well tamped in and given an application of tar, and the following day covered with a coat of patching material. The patch will iron out and become equal to the balance of the surface within a few days. The patrolman must be sure to fill every hole just as fast as it appears noticeable to the eye, even though it is not more than ¼ or ½ in. in depth. The outstanding points to insure satisfactory results are:

(1) Do not add more than 1 in. of new material during the season in which the treatment is given. In other words, if a gravel road is to be surface-treated any additions in material required in the line of re-surfacing should be applied the previous season and permitted to compact during the late fall, winter and spring. However, light applications of ½ to 1 in. can be made early in the spring and get good results the same season.

(2) The surface must be well compacted and uniform.

(3) The surface must be swept clean.

(4) The priming coat must be applied immediately after sweeping.

(5) The tar must be uniformly spread.

(6) The covering must be spread evenly, and a little less than 50 per cent of the required amount spread immediately following the distributor, the balance being applied later as required.

(7) If possible close the road to traffic while the second coat is being applied.

(8) The surface treatment must be followed up promptly and carefully by the patrolman or maintenance gang and patching material must be added just as soon as the slightest hole is noticeable on the surface.

(9) Unless plans are made to patch every hole the moment it appears, it is better not to attempt to maintain a gravel road with this type of surface treatment.

Approximate Costs—The first tar surface treatment of a gravel road 20 ft. wide will cost from $900 to $1,200 per mile. This includes the necessary preparation of the surface, the follow-up maintenance, and the entire patching cost for the season.

Preparing the Surface for Retreatment—Where a road has been previously treated by this method, preparation for retreatment is as follows: Any portions of the surface that are in perfect condition showing no holes, ridges or wrinkles, may be retreated without scarifying or breaking up with a blade grader. Those portions that are slightly uneven should be gone over with a heavy blade grader early in the spring when the tar skin coat is inclined to be loosened up a trifle from frost action or weather conditions, pushing the skin coat out to the shoulder of the road with the grader and following this up with a light grader such as is used in patrol work moving the material pushed to the side of the road back and forth across the surface of the road about twice a week for a two weeks' period. The best results are obtained when the temperature is from 60 to 70 deg. F.

This breaks up the old tar crust and the grader operations smooth up the surface of the road to a point where it is practically a perfect cross-section. When

the surface has become smooth and well compacted by these operations it is swept clean and the covering material placed at the edge in piles. The tar is applied in the same manner as outlined for the second coat application and generally no priming coat is required. The one coat required for the second year's surface treatment is approximately ¼ gal. The third year and thereafter a less amount is required unless additional width is treated.

The application of tar, spreading the covering, the follow-up patching, and everything connected with the work is done just the same as new surface treatment.

Remember, however, that while the surface treatment does bond and improve the character of the wearing surface, it does not increase the strength of the base or foundation. If the base is weak and drainage poor, certain portions of the road will undoubtedly break down under heavy truck traffic, especially when the frost is leaving the ground.

All sections that have broken up badly should be scarified and shaped up with a blade grader and on such sections after being shaped up and swept, a light priming coat is required before the main application.

As stated before, to maintain gravel road surfaces untreated it would require the replacement annually of 400 cu.yd. per mile or more, which, in this state, would cost not less than $1,000 a mile, as gravel delivered on the road costs an average of $2.50 per cubic yard. This cost, plus the annual patrol maintenance cost of $200 per mile, would result in a total annual cost of $1,200 per mile for an untreated surface, which is more than the treated surface would cost. It is, therefore, believed to be good business to conserve the material on gravel surfaces by a light tar surface treatment, giving a smooth road at no greater final cost.

Supervision of Water Treatment Plants in Michigan

Abstract of paper by Major Edward D. Rich, Director, Bureau of Engineering, Michigan Department of Health, Presented to the Iowa Section, American Water Works Association.

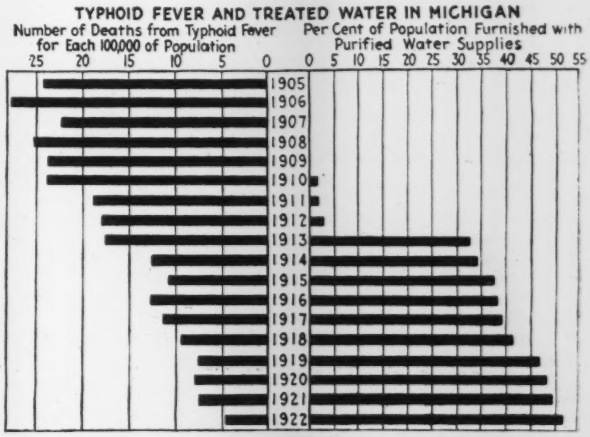
ALL FILTER plants in the state of Michigan maintain their own laboratories. Of the 50 chlorination plants, 41 have analyses made regularly, 33 in laboratories maintained by the municipality and 8 in other laboratories of recognized standing, none of these being of the commercial type. In four instances the chlorine dosing apparatus is kept for emergency use and regular analyses are not required. In two places chlorination has been installed recently and laboratory service has not yet been established. In only three cases are cities delinquent in conforming to state requirements in respect to laboratories.

Although the state is not densely populated, few, if any of the 104 surface water sources can be considered safe at all times for domestic use without some kind of treatment. The remainder of the total 305 supplies in the state are ground waters mostly good.

Local Analysis — When attempting to supervise waterworks systems for the purpose of controlling the sanitary quality of the water delivered it is decidedly important that the supervising body know the exact quality at all times and that some one directly connected with the water system be made responsible for maintaining the required quality. To accomplish this the State Board of Health adopted a resolution which required that after Jan. 1, 1916, whenever a water supply is subjected to treatment of any kind to improve its sanitary quality, the management must provide facilities for making laboratory examinations as frequently as deemed necessary by the State Board of Health and that the results of these examinations must be forwarded to the board each month on blanks furnished by the state.

Of course some difficulties were encountered in attempting to establish laboratories at each treatment plant and it was often difficult to find the proper person to place in charge of them. At the present time there are 50 laboratories in the state making water examinations regularly for 54 water systems and the results of these tests are reported each month to the Michigan Department of Health.

One could hardly expect each laboratory to do scientific work of the highest order, but it is significant that, so far as can be learned, even in the laboratories at the smaller plants the results continuously correspond very closely to those obtained from samples occasionally collected and



TYPHOID FEVER AND TREATED WATER IN MICHIGAN

examined in the laboratory of the State Department of Health at Lansing. By using prepared dehydrated media the bacteriological plantings are made comparatively simple and it has been found that by having some one from the State Department of Health spend about two days with some intelligent local person, sufficient instructions can be given to enable him to carry out routine analyses and properly fill out the report blanks. Whenever reports show that the analyst is in need of further instructions, or upon request, other visits are made and assistance is freely given.

Reports—It has been found important in giving the first instructions to specify that the analyst follow closely routine procedure only; he is not asked to interpret results but is simply required to record his findings on the report blanks. After he has had time to become acquainted with routine procedure we make all reasonable efforts possible to give instructions in interpretation of results and in the cause and effect of water supply contamination.

Some of our laboratories are located in high school buildings where one of the teachers performs the analyses and usually this has proved satisfactory where part time services must be accepted. This arrangement has decided educational advantages well worth considering.

The rapid decrease in typhoid fever in Michigan during the past ten years and especially in the cities which in former years had very unsatisfactory water supplies indicates good results from our efforts. In 1913 the death rate for this disease was 3.6 times the rate for 1922 in the state as a whole and 4.8 times the rate in the cities which now treat their water supplies.

Hollow Tile Fire Walls Permitted in Germany

Fire walls may be built of hollow tile under a new German building regulation. Previous regulations had required such walls to be solid, and this was interpreted to prohibit the use of hollow tiles or blocks. Under the revised regulation, hollow units will be permissible if the walls are of adequate strength and the cells do not form more than half the cross-sectional area.

New York Adopts Vialog Test for Smoothness Control

Instrument Attached to Automobile Inscribes Graphs of and Adds Up Irregularities in Road Surface Traveled Over

Smoothness Requirements in New York

By Col. Frederick Stuart Greene
Superintendent, New York State Department of Public Works, Albany, N. Y.

THE RESULTS of impact tests made during the last two years on experimental roads has brought forcibly to the attention of highway engineers the necessity of building smooth pavements. An irregular pavement not only gives discomfort to the traveling public and materially increases the wear and tear on vehicles traveling over it, but, more important, a rough pavement rapidly deteriorates, especially when the highway has to carry heavy traffic.

In the state of New York, our pavements are tested during construction with a 10-ft. straight-edge. Our specifications allow from ¼ in. to ½ in. irregularity, according to the type of pavement. The results obtained from this method, as shown in the finished pavement, have not been satisfactory, and in order to secure as smooth a pavement as possible we have determined to resort to the vialog test on all of our contracts.

The vialog is a mechanical device which was invented and developed by Harley Dunbar, an engineer in this

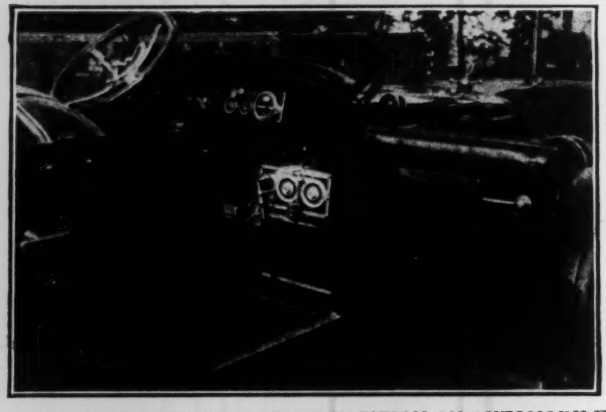


FIG. 1—VIALOG IN OPERATING POSITION ON AUTOMOBILE

department. Our experiments with this machine have been so satisfactory that we have recently added to our specifications the following requirements:

Before the pavement is finally accepted, a record vialog chart shall be made by the Bureau of Highways to determine surface irregularities. If these irregularities exceed ——— inches per mile, for any mile of pavement, the contractor shall reduce such irregularities by bush hammering, or other methods, as directed by the engineer, until the vialog chart shows that the variations in the pavement do not exceed ——— inches in any one mile.

From experience, we have found that the practical allowance for irregularities per mile for the various types of pavement, as shown by the vialog, is as follows:

Concrete—50 in. per mile of pavement
Brick—50 in. per mile of pavement
Asphalt Block—50 in. per mile of pavement
Bituminous Macadam Mixing Method—75 in. per mile of pavement
Bituminous Macadam—125 in. per mile of pavement

We feel that the use of this machine and the limitation of surface irregularities so that they shall not exceed the above inches per mile will not only result in a much better pavement, so far as riding qualities are concerned, but will give the state a longer life for its roads.

* * *

Vialog Operation and Graphs

By Harley Dunbar
Assistant Engineer, Bureau of Highways, Albany, N. Y.

AS USED for making smoothness surveys of New York highways the vialog is a compact recording instrument made of aluminum and is attached at or near the dash, Fig. 1. It has two recording pencils resting on a paper chart 6 in. wide. This chart is propelled through the instrument in proportion to the speed of the car by means of a flexible shaft geared to one of the front wheels. The horizontal scale of the chart is 1 in. = 50 ft. of road and the vertical scale is ½ in. = 1 in. of surface irregularities. Each pencil is connected with the front axle by means of a vertical shaft mounted on the side of the instrument and two horizontal arms, upper and lower; the upper arm connects the vertical shaft with the pencil, and the lower arm has one end pivoted to the shaft and a wire is run from the outer end of the arm through a flexible tube to a piston mounted vertically on the front axle near the front wheel. This piston works up and down inside of a cylinder attached to the frame of the car so that when either front wheel strikes a hole or bump in the pavement the motion is transmitted by means of the above described connection to the pencils causing them to draw an irregular or straight line according to whether the pavement is rough or smooth.

This chart, Fig. 2, is in plain view of the observer, enabling him to insert notes as the chart is being made. In addition to the chart an integrating device is mounted on the vertical shaft at the side of the instrument. This device constantly adds up the irregularities transmitted to the pencils, so that if the dial is read at the beginning of a road and at any time thereafter, the difference between the readings gives the amount of irregularities in the pavement. Readings may be taken every mile or as often as desired. By simply driving a car equipped with the vialog over a pavement at 20-30 miles per hour an autographic record is made of its condition, and this record together with the rating given by the dial furnishes an unbiased and reliable estimate of the surface condition or riding qualities of the pavement. In order to make the ratings taken from the dial comparable even though the instrument is installed on cars of different manufacture, it is necessary to calibrate each car and reduce the readings to inches instead of using readings direct from the dial. This is done by placing boards on a smooth pavement and running over them, recording the reading on the dial before and after. The difference in the two readings divided into the number of inches of irregular-

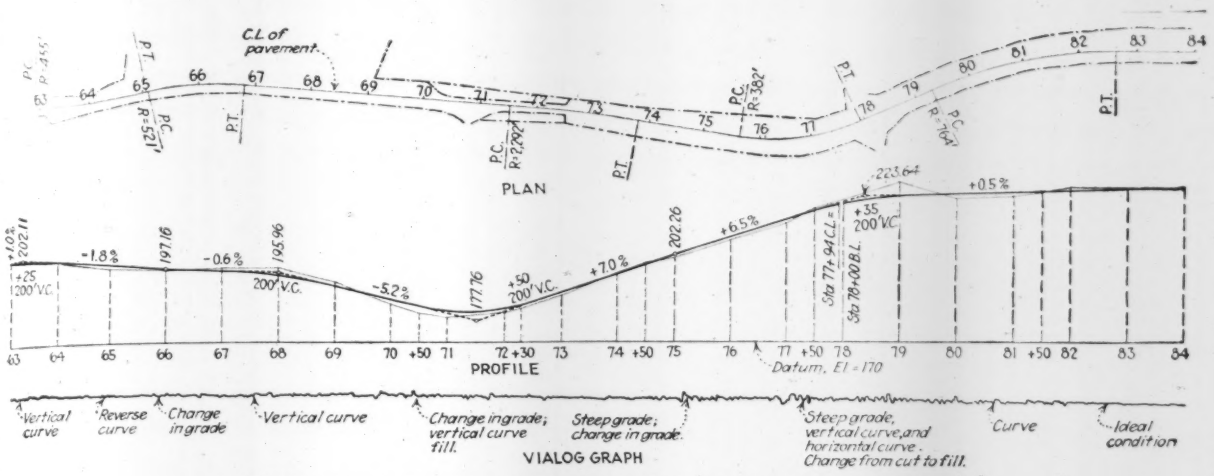


FIG. 3—PLAN, PROFILE AND VIALOG-GRAPH RECORD OF A ROAD

ities caused by the boards will give the necessary correction to apply to reduce the direct readings to inches.

A chart of a vialog survey is shown by Fig. 3. A study of this brings out very clearly the importance of close attention to details in construction work especially under adverse conditions.

Wherever a vertical curve or change in grade occurs a corresponding irregularity is shown by the vialog and between stations 77 and 80 where there is a commination of adverse conditions a corresponding result is noticeable in the graph. The writer did not actually read the dial for the short stretches of graph shown, as the chart was made without any special purpose in view except to record the condition of a new pavement, but a line such as between stations 72 to 74 + 50 indicates a surface well within the vialog requirements of 50 in. per mile whereas the graph between 77 and 80 indicates surface irregularities of 175 in. per mile.

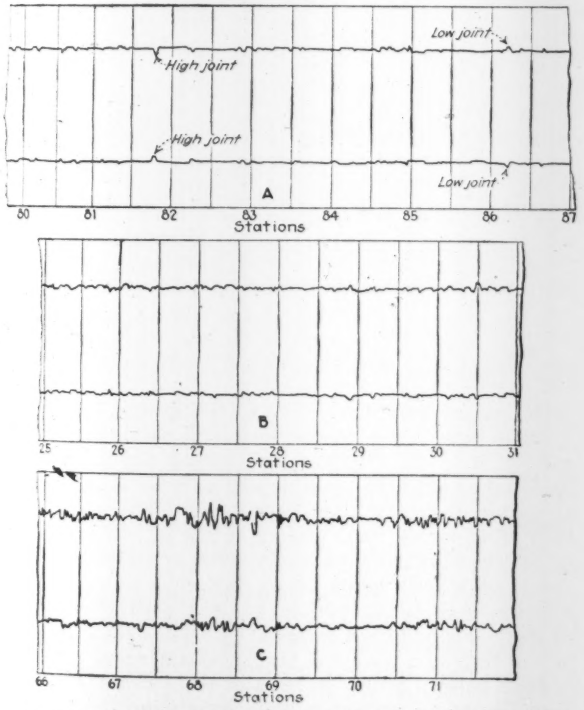


FIG. 2—SAMPLE GRAPHS FROM VIALOG INSPECTION
A—Very good concrete pavement 50 in. to the mile.
B—Very good bituminous macadam 125 in. to the mile.
C—Worn out waterbound macadam 560 in. to the mile.

* * *

Discussion of Smoothness Surveys

Furnished by the Bureau of Roads, New York

SINCE the spring of 1923 various vialog inspections have been made and recorded by the Bureau of Roads of New York. The results of one of the later of these inspections are given in the accompanying tabulation. The purpose of these inspections was to determine the work being done on flat grade in comparison with grades over 4 per cent. It was found that smooth work had been attained on grades of 5 and 6 per cent, such as roads 193, 8084 and 1609, whereas on road 5672 results are not so good on 7 to 8 per cent grades. These roads were not covered by the vialog specification for smoothness, the contracts having been let prior to Aug. 10 of this year, when the vialog specifications were first adopted. It is evident that very careful work will be necessary on grades of over 4 per cent in order to get results in concrete pavements that will bring them within the rating of 50 in. to the mile which has been required on contracts let since Aug. 10.

Referring to the tabulation, the ratings given for each of the pavements tell a story to engineers familiar with the conditions peculiar to the construction of each road. All of the concrete pavements were built with a longitudinal center joint formed by constructing the pavement one side at a time.

Road 5084 is a short stretch of 0.31 mile of dual type pavement with 6 ft. of macadam in the center and two strips of concrete 9 ft. wide on either side. This is a record of the east slab of concrete pavement only, and shows the excellent work that can be done by departmental forces with nothing to prevent careful attention to details. Under this pavement is 6 in. of old bituminous macadam which is furnishing an excellent base for the concrete as there is no evidence of movement in any of the slabs.

Road 193 is an example of very good work done by contract last year. Probably if a vialog record had been taken at the time it was first completed it would

have rated well under 50 in. per mile for its entire length. The second mile has 50 per cent of its length on a 6 per cent grade, showing that it is possible to attain smooth work on grades over 4 per cent up to 6 per cent. This pavement is on top of 6 in. of old water-bound macadam.

Road 8084 is new construction on clay soil. The portion built in 1922 must have moved considerably last spring as it has double the irregularities per mile of the portion built this year. This points out the importance of a firm, well-drained foundation even under reinforced concrete 7 in. and 9 in. thick. This road also has an example of a smooth pavement on a 6 per cent grade.

Road 8115 shows lack of uniformity in workmanship on the same contract, three miles of which rates 50 in. or better, with 1.1 miles jumping to 81 in.

Road 5672 is an example of the effect of 7 and 8 per cent grades on concrete, causing it to flow if mixed too wet without extra care being taken in finishing until it has set.

Road 8104 is an example of excellent workmanship.

Road 1609 has an example of hill on a 5 per cent grade, the slab on the west side of the pavement being smoother than on the east side This pavement runs quite uniform mile for mile on each slab.

Road 615 shows the marked improvement in workmanship after the organization had become broken in.

Roads 5253 and 8126 are examples of bituminous macadam penetration method, excellent results for that type of pavement.

Road 1541 has two or three miles of very good pavement such as the fourth and fifth miles and the last 0.85 mile. The first, second and third miles no doubt moved considerably during the spring and the sixth mile was affected by the uneven pouring of the bituminous material.

VIALOG INSPECTIONS OF PAVEMENTS AUGUST-SEPTEMBER, 1923

County	Road	Miles	Year	Total Inches for Road	Inches per Mile	Remarks
			CONCRETE PAVEMENTS			
Rensselaer	5,084	.31	1919	6	20	Dept. forces level grade East slab part of dual type
Albany	193	3.54	1922	200	56	West slab total length
		1.0		34	34	East slab first mile south end
		1.0		48	48	East slab second mile
		1.0		45	45	East slab third mile
		0.54		32	59	East slab north end Second mile has 2,300 ft. of 6 per cent grade
	8,084	.32	1923	13	40	6 per cent grade north slab
		1.00		30	30	First mile west of Normanskill includes .32 mile 6 per cent grade
		.9		26	29	North slab
		.9		27	30	South slab
		1.00		34	34	South slab Normanskill Bridge Sta. 582
		1.0	1922	80	80	South slab east of bridge
		1.0		77	77	South slab second mile
		1.0		61	61	South slab third mile
		0.32		16	53	South slab last three miles east end
						G. V. R. Arthur, engineer in charge of road 8,084, states that portion built in 1922 shows evidences of considerable movement during winter and spring of 1922-1923.
Cattaraugus	8,115	1	1923	50	50	First mile north end slab west
		1		48	48	Second mile
		1		44	44	First mile
		1.1		89	81	Last 1.1 mile south end slab
		1		42	42	Third mile east slab
		1		50	50	Second mile east slab
		1		48	48	First mile east slab Flat grades
Erie	15,672	1.1	1923	109	99	West end south slab, Sta. 0-58
		1		109	109	Sta. 60-113/0, south slab
		1		112	112	Sta. 60-113/0, north slab
		1.1		114	101	Sta. 0-58 7-8 per cent grades
Schuyler	8,110	1	1923	68	68	East slab south end
		0.50		27	54	East slab north end
Steuben	8,104	2.78	1923	117	40	West slab total length
		1.0		34	34	East slab south end
		1.0		36	36	East slab middle mile
		0.80		34	42	East slab north end
	742 (R. C. 3,021)	1.00		66	66	
Schenectady	1,609	.3	1922	18	60	East slab south end, Hill max. grade 5 per cent
		1.0		43	43	East slab includes .3 mile above
		1.0		46	46	East slab second mile
		1.0		56	56	East slab third mile
		1.0	1923	56	56	East slab fourth mile
		0.14		10	71	East slab north end
		0.14		8	57	West slab north end
		1.00		54	54	West slab fourth mile
		1.00	1922	51	51	West slab third mile
		1.00		51	51	West slab second mile
		1.00		56	56	West slab first mile
		.30		14	47	West slab Hill 5 per cent
Columbia	615 (R. C. 3,022)	1.0	1923	46	46	First mile built new organization
		1.0		37	37	Second mile built organization broken in
			BITUMINOUS MACADAM PAVEMENTS			
Steuben	8,126	1.01	1923	103	102	
	5,253 (R. C. 3,044)	3.00		299	100	
	5,253	1.00	1921	82	82	
Albany	1,541	1.00	1922	179	179	South end first mile
		1.00		137	137	Second mile
		1.00		182	182	Third mile
		1.00		115	115	Fourth mile
		1.00		130	130	Fifth mile
		1.00		145	145	Sixth mile
		0.85		63	101	Last .85 mile Altamont
						This road built in 1922 with 12-in. foundation course on clay soil.

Asphalt Macadam Construction with Trailers and Tractor

Roadside Quarries Reduce Haul—Two Men Smooth Stone Spread by Trailers—Heaped Loads Reduce Trailer Equipment

BY W. C. PATRICK
Roanoke, Va.

HAULAGE, an important item in all road construction, is particularly a major operation in constructing asphalt macadam roads. In this work it is not merely a process of conveying materials to a destination from which they are handled into the road structure; it also includes approximate placing, at least, of these materials. The materials are distributed on the road as a part of the hauling process. This is true both of the stone and of the asphaltic binder. Selection of the hauling process and organization of the haulage operations become, therefore, subjects for special study in each asphalt macadam road building job.

In building a 10-mile penetration macadam road this last season in Botetourt County, Virginia, interesting procedure in tractor and trailer haulage was developed. The road was 12 ft. of macadam, with 4-ft. shoulders, and is built of local rock. In part the road follows the route of a macadam road which was built many years ago, but in the main the location is entirely new, many bad curves having been flattened, or eliminated, and the "bite" taken from practically all the grades.

Steps were taken at the outset to establish quarries and set up rock crushing and sizing plants as nearly three miles apart as possible and as near to the location as suitable quarry sites permitted. Thus a maximum haul of 1½ miles, from quarry to the most distant point at which work was to begin, was established. While the grading was being done, rock crushing, sizing and storing were being pushed until a considerable stock of materials had been established. Then came the problem of finding a means to transport and spread the rock.

Just before actual work was to begin, the contractors agreed to try out a train consisting of four Troy reversible spreader type trailers, each with a water level capacity of 3½ cu.yd. While eight trailers were

advised, owing to the absence of steep grades and due to the fact that the train could be divided into groups of four trailers each, one group being left to receive load at the storage pile while the other was being drawn to the point of operation, if so desired, the contractors were skeptical both as to the results to be obtained and as to obtaining the approval of the district engineer under whose supervision the work was to be done, as it seemed advisable and desirable to operate this train directly over the prepared subgrade from quarry to spreading point. They, therefore, bought four trailers, believing that by using a steam shovel for loading at the storage piles they could, where the maximum haul would not exceed 1½ miles, deliver sufficient material each day to keep the work going.

The trailers, with the tractor, were delivered on the

FIG. 1—STEAM SHOVEL LOADING TRAILERS
Loads are heaped to 4½ cu.yd. in a 3½ cu.yd. trailer body to cut down number of trailers required.

FIG. 2—TRAILER TRAIN IN POSITION FOR SPREADING
Side strips are spread first and then the center strip making an 18-ft. road.

location and began work about June 15 under the direction of N. E. Fisher, superintendent of construction. As stated, a steam shovel is employed in loading the trailers at the storage piles and by heaping the load each trailer is made to carry approximately 4½ cu.yd. of rock instead of 3½ cu.yd., their water level capacity. Thus, the train of four trailers carries approximately 18 cu.yd. per trip. It makes an average of ten to twelve round trips per day of ten hours, from storage pile to job and return, the shorter hauls making more trips possible while the longer hauls reduce the number somewhat. The speed of the train, under load, is about three miles per hour, while the return, empty, is made at a speed somewhat in excess of three miles per hour and could be made at a much higher speed if the towing tractor were equipped with a high-speed gear. The train is operated by two men, a tractor driver or engineer, and a trainman. The former receives the compensation of a skilled laborer, while the latter is rated on a common laborer basis.

Arriving at the point at which the spread is to begin, the tractor is detached and brought around to the opposite end of the train where it is attached preparatory to drawing the train back in the direction from which it has just come. At the same time, the trainman reverses the trailers by locking the steering mechanism at the end which has just been the front and unlocking it at the opposite end. The train starts forward at a speed of probably 1 to 1½ miles per hour and just as the bottom door of the trailer nearest the tractor reaches a point directly over the spot where the last spread stopped, or the new spread is to begin, the trainman trips the trailer's dumping lever and the rock begins to spread out on the subgrade. Each of the remaining trailers is emptied in this manner, until the entire train's load is spread. The first train load is spread on one side of the subgrade, a second is spread on the opposite side, and a third is spread down the center. Each spread being 6 ft. wide, the entire 18-ft. subgrade is covered and is then ready for such hand leveling as may be necessary.

There is no great impact when the stone comes into contact with the prepared subgrade to cause an uneven distribution of the aggregate and unduly pack the earth directly beneath it as would be the case were the entire load discharged at once and spread later by hand or some mechanical device. Neither do the broad steel tires of the trailers' wheels damage the subgrade in passing over it. The effect is more that of a road roller than otherwise. The heavy impact is prevented by releasing only just the quantity of stone necessary at the time and that from a point at no height from the ground. Only two men are required to do such leveling as is found necessary after this train has done its work.

The course of No. 2 stone which is composed, naturally, of much smaller sized crushed stone than the No. 1, is applied in the same manner as above described, the haul being made over the No. 1 course without disturbing or damaging it, the trailer's bottom doors being adjusted so as to give the proper depth of spread for the smaller aggregate.

No cost figures are available. However, it is understood that a considerably better grade of work is being turned out at less unit cost than with team haulage.

The work described is being done under the direction of the Virginia Highway Commission, H. T. Ammerman, district engineer, by Boxley, Chisholm & Hall, an associate company of W. W. Boxley & Co., Roanoke, Va., contractors.

Applications Overtax the Patent Office

The annual report of the Commissioner of Patents to the Secretary of the Interior for the fiscal year 1923 shows that during the last two fiscal years the Patent Office received an average of 9,000 applications a month, or 216,170 applications for patents, trade-marks, prints and labels—over 5,000 more than in the previous two years. The fees received during the past year amounted to $3,026,486.36, the largest amount ever received by the Patent Office in one year. A revenue of $241,738.30 was paid into the Treasury for the sale of 2,417,383 printed copies of specifications of patents.

Concrete Pavement Reinforcement Logically Designed

By George D. Burr
Clifford Older
A. T. Goldbeck

Design for King County Roads Based on Bates Road, Pittsburg Road and Arlington Farm Tests—Discussed by the Engineers of the Bates Road and the Chief of Tests of the Bureau of Public Roads

PRIOR to the year 1922, pavement reinforcing, consisting principally of flat wire mesh, was laid indiscriminately in the slab.

The weight of the mesh used was mostly guesswork. If slabs with 25-lb. mesh failed, 40-lb. mesh was thereafter used.

Steel bars were not used generally until the year 1922. Their weight, disposition and necessity for use at all were, as in the case of wire mesh determined by individual experience.

A Design Based on Tests

By George D. Burr
Assistant King County Engineer, Seattle, Wash.

TO GET away from the waste and disadvantages of the guess and experience methods of design, use was made of the recent tests conducted by the United States at Arlington, and by the state of Illinois on the Bates Road. These experiments provided much useful information but failed to show the distribution of the load on the subgrade, with a central load on the slab. This information was supplied by the highway tests at Pittsburg.

There is one notable variable in the design of a paving slab that should be corrected by enforced legislation. This is the load that the highway must carry. Until such time as our loading laws are enforced, the best that can be done is to determine the weights of vehicles that are using the highways, and add a reasonable amount for development. I have used the maximum allowed by the Washington state law, which is axle loads of 18,500 lb. spaced 12 ft. apart. The initial assumptions are as follows:

1. The subgrade is uniformly elastic up to the limit of the bearing power used.

2. The subgrade bearing power is determined by using a bearing block at least 6 sq.ft. in area, and is the reaction obtained when the deflection of the subgrade is 0.12 in. under the point of application of the load.

3. The elastic curve of the loaded slab is shaped as determined by the Arlington experiments.

4. Half of the load is carried by the subgrade between the points of contraflexure of the elastic curve when the slab is loaded.

5. When there is a sudden change from a hot to a cold atmosphere, the corners of the slab curl up and receive no support from the subgrade.

These assumptions are all well-founded on experience. Assumption (4) is the result of a close approximation to a beam uniformly loaded and continuous over several supports. This analogy may be more readily appreciated if we consider wheel loads as reactions and the subgrade bearing as the load. The errors in thtse assumptions are all on the side of safety. There is one more assumption, still in a slightly experimental stage, which we will call assumption 6. It is:

6. When the central portion of the slab is designed with a thickness corresponding to that generally found necessary in accordance with the Arlington experiments, all failures will be progressive from the edges to the center or will be found at the corners.

The result of this assumption is to require steel in the middle only for the purposes of distributing stresses and taking care of moments caused by unintentional local settlement of the subgrade.

The methods used in designing the necessary reinforcement for a four-mile concrete road, known as the Renton-Maple Valley Road, now under construction. Fig. 1, were as follows:

Concrete in compression 800 lb. per square inch.
Steel in tension, 24,000 lb. per square inch.
Subgrade bearing power, measured for 0.12 inch.
Deflection 900 lb. per square foot.
Axle load 18,500 lb. plus 50 per cent impact.

It will be noted that the unit stresses used are unusually high, a large factor of safety not being justified in this class of work.

Entering the chart for the required thickness for centers from impact tests at Arlington with the wheel load of 9,250 lb., a 6½-in. slab is sufficient for the central portion of the slab. The edges are to be thickened to 9 in.

Longitudinal Reinforcement—By measurement it is found to be general that for a 6½-in. concrete slab wher there is a 0.12-in. deflection, under the load there is a 0.10-in. deflection at the point of contraflexure of the elastic curve; 10/12 of 900 lb. = 750 lb. = subgrade bearing at point of contraflexure (see assumption 1); $\frac{900 + 750}{2} = 825$ lb. per square foot = average subgrade bearing between points of contraflexure for soil having a 900-lb. per square foot bearing power. And $\frac{(9{,}250)\ 1.5}{2} = 6{,}937.5$ lb., which is required to be supported by the pavement between the points of contraflexure; that is, 6,937.5 lb. must be carried by the pavement slab to points beyond the point of contraflexure. To find the distance apart of the points of contraflexure, consider the area (represented by letter A) to be a parabola with its base twice as long as its altitude (and the base represented by letter L).

$$\text{Then } A = \frac{2L}{3} \cdot \frac{L}{2} \text{ and } L = \sqrt{3A}$$

$$\text{But } A = \frac{(\text{load} + 50 \text{ per cent impact})\ \frac{1}{2}}{\text{average subgrade bearing}}$$

$$\text{Therefore } L = \sqrt{3\ \frac{6937.5}{825}} = 5.02 \text{ ft.} = 60 \text{ in., approx.}$$

The maximum moment will then be as for a single beam with span L and concentrated load of 6,937.5 lb.

$$M = \frac{WL}{4} = \frac{6{,}937.5 \times 60}{4} = 104{,}000 \text{ in.-lb.}$$

The edge of the slab is now designed as a single reinforced-concrete beam.

It will be seen that the higher the bearing power of the subgrade the shorter the distance between points of contraflexure and consequently the smaller the amount of steel required until we reach the subgrade that requires no steel at all in the bottom of the edges of the slab. In other words the softer the subgrade the stiffer we must make our paving slab by means of reinforcement in accordance with the definite law outlined above. It will be noted that there are negative bending movements beyond the point of contraflexure. They are small in comparison to the positive moments and usually not in excess of the tensile strength of the concrete. However, to take care of these negative moments in case they should become excessive for any reason by local settlement of the slab, a ½-in. square bar is run along the top of the edge.

The ends of a portion of the longitudinal bars are bent up in order to take care of the negative bending moment occasioned as outlined in assumption 5. The maximum moment at the corners is a function of the subgrade and the relative temperature of the top and bottom of the slab, but for most practical work with the thickness of slabs that we use, it may be considered as being at a point 2 to 3½ ft. distant from the corner.

Lateral Reinforcement—The theory of lateral flexure of paving slabs shows that maximum moments, excepting at corners, occur at the middle of the ends of the slabs, and are both positive and negative. The greatest of these are negative due to the curling up of the edges

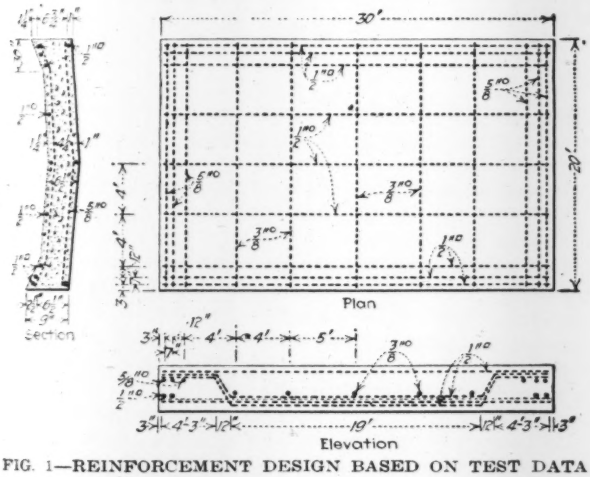


FIG. 1—REINFORCEMENT DESIGN BASED ON TEST DATA

of the slab, the softening of the subgrade near the edges of the pavement by saturation with water and in the center by the action of frost. In the lateral reinforcement I have neglected impact.

For 20-ft. pavement the maximum clear distance between the two lines of traffic is considered to be 7 ft. The total of two axle loads in line is 37,000 lb. of which three-quarters is transmitted to the subgrade outside of the 7-ft. clear distance. The remaining one quarter or 9,250 lb. can be considered uniformly distributed on the subgrade along the 7-ft. interval. The resulting moment is $\frac{(9{,}250)\ 84}{8} = 97{,}125$ in.-lb. The top reinforcement of the edge is accordingly designed. It will be noted that the narrower the pavement the smaller the amount of top lateral reinforcement required.

The bottom lateral reinforcement is designed in exactly the same manner as the longitudinal reinforcement, excepting that the allowance of 50 per cent for impact has been omitted.

The amount of steel required by this method of design is not excessive except in the case of very soft subgrade. A slab may, therefore, be economically reinforced for a soft subgrade up to the point where the cost of the steel for the reinforcement exceeds the cost of reconstructing the subgrade to secure a more stable base. The amount of steel expressed in pounds per 100 sq.ft. is 84 lb. for a 30-ft. slab and 99 lb. for a 20-ft. slab. The quantity of steel compares very favorably with other systems of design, and insures a slab of greatly superior strength.

The choice between 30 and 20-ft. slabs should be based on the probability of local settlements occurring. The greater the danger of settlement the shorter the length of the slab that should be used. However, in no case should a slab under 15 ft. in length be used.

* * *

Discussion

BY CLIFFORD OLDER
State Highway Engineer of Illinois

REFERENCE is made to at least one principle that cannot be stressed too often. Unless drastic steps are taken to control highway overloads, serious destruction of pavements will continue whether they be designed by rational methods or in accordance with the observed behavior of existing pavements. Unless forcibly restrained, irresponsible individuals will always be found who, for temporary convenience or profit, will move over the public highways vehicles so loaded as to impose wheel loads many times greater than the average maximum required for the economical transport of goods.

The analytical method of design used by Mr. Burr depends, as he states, upon six assumptions which are more or less interrelated. Assumptions 3, 4, 5 and 6 will not be discussed. Assumptions 1 and 2, however, being fundamental are worth considering carefully inasmuch as if these assumptions are not justified, the method of design, if for no other reason, could not well be accepted. Assumptions 1 and 2 are as follows:

1. The subgrade is uniformly elastic up to the limit of the bearing power used.

2. The subgrade bearing power is determined by using a bearing block at least 5 sq.ft. in area, and is the reaction obtained when deflection of the subgrade is 0.12 in. under the point of application of the load.

For several years the Illinois Highway Department has been conducting investigations designed to throw light upon the behavior of subgrade soils when subjected under various conditions to loads, both static and repeated. It should be held in mind that highway traffic imposes oft-repeated loads on both the slab and the subgrade. In connection with this work concrete slabs 3 ft. in diameter were cast on the shoulders at the side of existing road slabs, the bottom of these slabs being located at the elevation of the bottom of the road slabs. From time to time repeated loads of varying amounts have been applied to the center of these slabs. Invariably the first application of load caused a marked depression of the entire slab which, upon release of the load, did not disappear. Further, after a period of rest of more than a few minutes' duration, the same phenomenon almost invariably appeared. Following the first application of load, after a period of rest

with the moisture content varying from 25 per cent to 31 per cent of the dry weight of the soil (which may perhaps be considered normal for this soil), subsequent applications of a load of 6, 8 or 10 lb. per square inch of bearing area caused in almost all cases a progressive depression of the entire slab, the progressive depression being measured after the release of the load. The amount of this progressive depression per load application is sometimes very slight, but nevertheless apparently continues indefinitely. Other conditions being constant, it does not seem to vary much with variations of soil moisture content up to about 30 per cent. It is known, however, that this particular subgrade soil is capable of holding capillary moisture under certain conditions up to at least 40 per cent of the dry weight of the soil. Its behavior under this extreme condition has not yet been observed.

There is another factor which introduces perhaps a still greater uncertainty, and that relates to the change in the so-called elastic behavior of the soil after the ground has been frozen and again thawed out. For example, the subgrade under Slab No. 2 on Dec. 16,

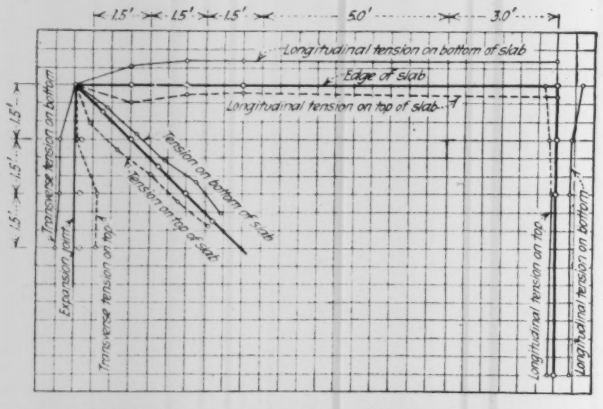


FIG. 2—MAXIMUM FIBER DEFORMATIONS IN 6-IN. PLAIN CONCRETE SLAB ON WET SUBGRADE

1921, showed a moisture content of 28.7 per cent and permanent depression, after the release of the first application of the 6-lb. per square inch load, of 0.005 in.; after the release of the tenth application, 0.001 in., the intermediate applications showing a progressive permanent depression between these limits. On March 8, 1922, with subgrade moisture content 27.5 per cent, the permanent depression after release of first application was 0.03 in.; after release of the tenth application, was 0.06 in., the intermediate applications showing progressive permanent depressions on practically a straight line ratio. Inasmuch as the moisture content on March 8 was lower than on Dec. 16, this would seem to indicate that the loosening of the soil, due to freezing and thawing, may have an effect upon the behavior of the soil as great as a very marked change in moisture content.

Freezing and thawing combined with increased moisture content may introduce still greater discrepancies. For example: Slab No. 1 on Dec. 6, 1921, showed a depression under a 6-lb. per square inch load of 0.003 in. and a permanent depression after the release of this application of about 0.003 in.; after the tenth load the permanent depression had increased to but 0.005 in. The moisture content at this time was 28 per cent. Between Dec. 6 and Feb. 20, 1922, the ground had frozen and thawed several times and the moisture content had increased to 33.8 per cent. The depression under a 6-lb. per square inch load was 0.13 in.; and after the release of this application a permanent depression of 0.009 in. remained. Subsequent application caused progressive permanent depressions, the accumulated total depression under the tenth application of the same load being 0.2 in., and upon release of the load the residual permanent depression was 0.15 in.

The examples cited are typical of many hundreds of observations on loaded areas varying between wide limits. Up to this time data of this character are available only for one type of soil. We have under way, however, similar tests on about 30 soils, covering, it is believed, the range to be found in the state of Illinois. The observations made so far suggest to us that the general behavior of at least most of them is the same.

The bearing of these tests upon Mr. Burr's discussion seems to indicate that his assumption 1 is decidedly unsafe for at least certain types of subgrade soils; and that, granted assumption 1 could be used, the method suggested in assumption 2 for determining the subgrade bearing power is so uncertain that results based thereon would be of little value.

Unfortunately, research on soils does not yet seem to have progressed to such an extent as to justify the offering of alternatives.

* * *

Discussion

BY A. T. GOLDBECK
Chief, Division of Tests, Bureau of Public Roads

THE accuracy of any design theory is controlled largely by the assumptions upon which the theory is based. It is believed that in general the first five of the assumptions made by Mr. Burr are reasonably correct, although assumption 4, "That half of the load is carried by the subgrade between the points of contraflexure of the elastic curve when the slab is loaded at the edge," may or may not be correct depending largely upon his subgrade conditions. It is quite apparent that a hard or soft subgrade will alter the relative amounts of load concentration carried by the slab and subgrade, respectively. Assumption 6 is to be regarded as approximate and its validity also is dependent upon the character of subgrade support.

With regard to the high unit stress assumed, particularly with regard to the use of 24,000 lb. per square inch in the steel, it must of course be recognized that under such an assumption all resisting moment due to the concrete must be neglected, for the concrete is cracked under comparatively low unit stress in the steel. Thus, if perfect bond exists between steel and concrete and the modulus of rupture of the concrete is 700 lb. per square inch the stress in the steel will be approximately $700 \times \frac{30,000,000}{3,000,000} = 7,000$ lb. per square inch when the concrete cracks. The concrete alone has considerable resisting moment, the value of which is lost at the particular section where a crack is formed. However, even when a crack is formed, the concrete is still capable of resisting bending when the load is placed at the crack, for it is then carried by cantilever action of the adjacent slabs. The question should then be well considered: Can we, when designing a reinforced-

concrete pavement, economically neglect the resisting moment of the concrete? Mr. Burr evidently has not taken this into account. It is not stated by Mr. Burr what width of strip along the edge is considered effective in carrying the wheel load. This has probably been neglected since the steel is counted on entirely for taking the tensile stresses.

With regard to lateral bending, nothing definite can be said as to the accuracy of Mr. Burr's assumptions. I can conceive of instances in which his assumptions would not be sufficiently severe. The matter of the effective width over which the wheel loads may be considered as carried has likewise not been stated, but this too at the present time is quite indefinite.

Under severe frost action, unequal subgrade shrinkage or swelling, warping due to temperature or moisture inequalities, very high lateral stresses may occur in an 18- or 20-ft. concrete road, and it seems to be questionable economy to try to make the slabs sufficiently strong transversely to resist longitudinal cracking when by the use of a center joint the necessity for such high transverse strength can be eliminated.

In Fig. 2 there is shown a diagram of maximum deformations in a plain concrete slab under the action of traffic. This diagram shows that Mr. Burr has placed his steel in the most advantageous position for taking care of the stress due to traffic, and I am quite certain a road of this design will give a good account of itself. I should like, however to see further studies made looking into the relative economy of different designs with the following points in mind:

1. The use of a center longitudinal joint.
2. Due allowance for the resistance of plain concrete to bending.

Traffic stresses are by no means the only stresses to which a concrete road is subjected. Generally the bottom of the slab is continuously in a moist condition, whereas the top is alternately wet and dry. In addition, the top of the slab is subjected to greater extremes of temperature than the bottom. The expansion and contraction of the concrete due to these effects are naturally, therefore, greater at the top of the slab. Should the above effects not be the basis for the design of the steel rather than the bending stress effect of traffic?

Barge Transfer Terminals for Chicago

Selection of sites for public water terminals on the Chicago river, in view of the probability of future development of barge traffic on a Lake-and-Gulf Waterway, is advocated in a recent memorandum on the Chicago harbor problem, by Major Rufus W. Putnam, Corps of Engineers, U. S. Army. Facilities for interchange between barge and lake carriers can be arranged at the breakwater, off Grant Park, thus keeping large vessels out of the river. For interchange between barges and railroads, a site west of the Ashland Ave. bridge over the west fork of the river is suggested, this being in touch with the Chicago River & Indiana R.R., which would provide belt-line service. Warehouses, storage yards, tracks and freight-handling machinery would be required at such a terminal. For interchange between barges and trucks, a terminal at the junction of the north and south branches of the Chicago River is suggested. This would include a wharf along the South Water St., east of the Lake St. bridge, with two piers and slips extending out from the north bank. Warehouses would be built on the wharf and piers.

"Original Cost" Unsatisfactory Basis for Valuation, Says U. S. Court

THE DISTRICT Court of the United States for the Southern District of Illinois has recently granted an injunction to the Streator Aqueduct Co. restraining the Illinois Commerce Commission from interfering with the schedule of rates which the company has put into effect. In connection with this decision of the court are a number of elements of more than local interest. The court held that the commission had no power to suspend the effective date of the schedule filed by the utility company for a longer period than that specified in the law under which the commission was created. It also held, however, that it was the duty of the commission to proceed with the final determination of the investigation of the question of rates, even though the period specified in the law had been exceeded.

In considering the item of going value, the court stated: "The going value is property which cannot be taken from it (the utility) except by due process of law, and it is such property as the plaintiff is entitled to the enjoyment thereof, and where it exists it must be considered as one of the important elements in determining the reasonableness or unreasonableness of a rate charge or which it is proposed to charge."

The court stated that the cost of the rate proceedings should be amortized over a period of years and that the discount at which bonds of the company are sold should be amortized during the life of the bonds.

With reference to the method of valuation, the opinion said: "While the item of original cost may be considered where the circumstances and conditions and times bear some resemblance to those under consideration, yet it is not and should not be controlling unless they are identical or substantially so. It is shown that many of the items of the commission's engineer were based upon figures prior to 1910 and some prior to 1900, and that the commission in reaching the findings upon which it based its order of May 25, 1922, attempted to value the property without according any weight to the wholly enhanced cost of material, labor, supplies, etc., over those prevailing prior to 1914, when as a matter of common knowledge the increase was great."

With reference to deficits in the operation of the property, the opinion said. "There is admitted evidence of deficits in the operation of the property. These should be acertained and amortized."

District Majority Rule on Zoning in Quebec

A by-law just adopted by the municipal authorities of Quebec gives the say as to the admission of new industrial establishments of specified kinds to a majority of the voters residing in the voting district in question. The by-law reads: "No permit shall be granted by the city for the establishment of woodyards, stables containing more than three stalls, ice-houses, public garages, gasoline stations, automobile repair or paint-shops or shops where any automobile, structural member, part of accessory, whatsoever, is manufactured or repaired, unless the person, firm, syndicate, company or corporation desiring to obtain a permit to that effect appends to his or its application the written consent of at least the majority of the municipal electors residing or having place of business in the electoral district."

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Printing Weekly Highway Service Maps Showing Detours

By H. J. Kuelling

Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

IN A STATE the size of Wisconsin where there are upwards of 300 construction jobs in operation simultaneously on the state trunk highway system during the summer season, is it any wonder that the average motorist on an extended trip asks: "I wonder how Route No. 10 is? How much construction work is there in progress? Do I have to detour? If so, how many times, and how long are the detours, and what is their condition, etc., etc.?" Practically all hotels, garages, chambers of commerce, auto clubs and service stations are called upon daily to answer these questions for the motorist.

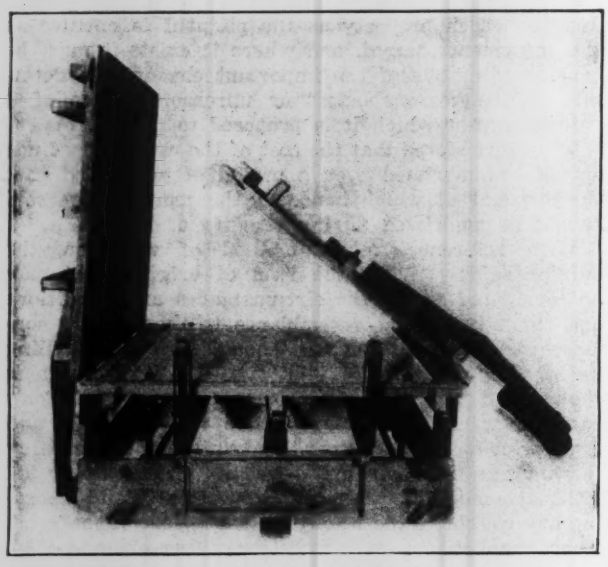


FIG. 1—DEVICE PRINTS DETOURS ON ROAD MAPS

In order that good and reliable information as to detours may be made available, the Wisconsin Highway Commission deemed it advisable to issue a weekly map showing this information and to place it in the hands of those who were really called upon to give out touring information to large numbers of motorists. In order not to discriminate against any firm or individual, the service was offered to the subscriber at actual cost of production (printing, mailing, etc.). The first year this plan was in operation the list of subscribers consisted of about a hundred leading hotels, garages, service stations and auto clubs. This season the list has grown to approximately 400 subscribers, including several from adjoining states. The service is also furnished to the highway departments of neighboring states in order that they may give up-to-date and reliable information to motorists entering Wisconsin. The service is started May 1 and a new map is issued and furnished to each subscriber weekly until Nov. 15.

Data relative to the location, length and condition of the detours and construction jobs are received at the main office on Tuesday of each week from each of the nine division offices. This information covers all the work in progress on the state trunk highway system. As subsequent changes take place they are covered by the weekly letter and notes from the division office to the main office. Standard cards are used in reporting the information to the main office. All additional jobs are reported on a pink card, all removals on a blue card, and the regular condition reports are made on white cards. This facilitates the work at the main office.

The information is immediately assembled at the main office and by the use of the printing press shown in Fig. 1, it is printed on maps specially prepared for this service. Two colors are used in the overprint, each printed by one of the two hinged plates. Red is used to indicate where the road is closed to travel. Green is used to show the marked and maintained detours; also to show construction jobs where the traveler may drive through with a reasonable degree of comfort. A full green line indicates that the detour or construction job is in good shape for travel; a broken green line indicates that it is in poor shape for travel but that the motorist can get through. The map, 40x45 in., shows the state trunk system, together with the principal secondary roads. Cities, villages, camp sites, state parks, lakes and other places of interest to the motorist are also shown on the maps.

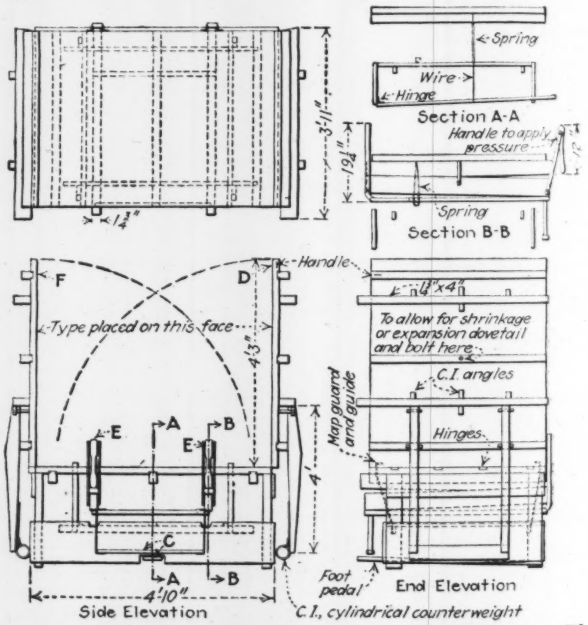


FIG. 2—PRESS FOR PRINTING HIGHWAY SERVICE MAPS

Details of the press are shown in Fig. 2. In printing, the operator first presses down on the pedal and bar at *C*. He then lowers one leaf by the handle at *D*, and applies pressure by means of the hinged lever handles at *E*. This leaf is then raised and the same operation repeated with the other, at *F*.

The weekly set-up is prepared as follows: A base map is placed within the guides on the horizontal plate of the press. On this map are located the individual detours and construction jobs. Rubber type about $\frac{5}{8}$ in. thick, specially made for this purpose, is cut to the desired length and made to conform to the location and condition of the detour or construction job. This type is laid with its printing face down directly on the base map. On the back is pasted a little glue. If the type is for the green plate, this plate is lowered and pressure is applied by the levers so that the type will stick at the proper place on the plate. The plate is then raised and the type is tacked on with small brads. This method is followed for each job and detour, care being exercised to get the type on the proper plate.

When all additions and changes are placed on the printing plates, the work is ready for the actual printing. The press is usually prepared on Tuesday afternoon and printing starts on Wednesday morning. Two operators are necessary; one man inking the green plate and the other inking the red plate. Printer's ink is used and the type is inked by the use of gelatin rollers, manipulated by hand. The ink is thoroughly mixed with a quantity of ox-drier on glass plates. In order to keep it from smearing when the maps are folded for mailing it is used very sparingly, only a thin film of ink being kept on the rollers. To print the 400 copies each week requires about 3½ hours.

As soon as the printing is started, the work of folding maps and preparing them for mailing is begun. The envelopes are usually addressed on Tuesday by an addressograph and are on hand early Wednesday morning to be filled. All work preparatory to mailing is done by 2 p.m. and the entire lot is taken directly to the post office so that they will get into the afternoon mail. The envelopes are usually grouped alphabetically in order to facilitate the work of the postal clerks.

Before being granted this service, each subscriber must agree to have a suitable frame upon which to display the map, keeping it in a conspicuous place, also to replace the old map each week by the new one.

The approximate weekly cost of labor in getting out these maps is shown in the accompanying table.

WEEKLY LABOR COST OF HIGHWAY SERVICE MAPS

One man at each of the nine division offices, preparing sketches, cards and reports, 2 hours, each per week (9 × 2) = 18 hrs. at $1	$18.00
One man at main office to assemble information and make set-up, also to help in printing, 8 hours per week @ $0.70	5.60
One man at main office to help in printing, 4 hours @ $0.90	3.60
One office clerk to fold and prepare maps for mailing, 5 hours @ $0.50	2.50
Total	$29.70

Highway "Kink" Articles in this Issue:

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By F. M. Balsley — Wisconsin

Improved Concrete Road Straight Edge
By R. L. Hufford — Iowa

Concrete Shoulders Widen Highway
By F. A. Gardner — New Hampshire

Road in Kentucky Has Concrete Rails
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Adapting Proven Principles to Local Conditions
By C. N. Conner — North Carolina

Adjusting Device for Plumb Bob
By W. C. West — Michigan

Performance Data of Automotive Equipment
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Baled Straw as a Support for Cement in Storage Sheds

By F. M. Balsley,
Chief Inspector, Wisconsin Highway Commission, Madison, Wis.

IT HAS become standard practice for states, counties and contractors to store cement in sufficient quantities well in advance of construction so that an adequate supply is insured at all times, regardless of the efficiency of the car service. The type of floor, size of sills, joists and flooring to support such heavy material as cement, has been discussed at some length in our engineering journals. At the best, the cost of these floors is an expensive item.

One of the superintendents for the R. F. Conway Co., of Chicago, now working on the Freeport-Forreston road in Illinois, has a very good solution of this problem. I am passing the idea on in the hope that it may be of use to others having similar problems. In place of heavy timbers and plank, he floors his cement shed with baled straw. The bales are laid like paving blocks with the wire side up. The wires are not cut.

Baled straw costs about $15 per ton in place. The bales will average about 85 lb. each, and the surface area is approximately 8 sq.ft. per bale. Assuming 24 bales to the ton, one ton of straw would cover about 192 sq.ft. of area at a cost of about eight cents per square foot. This is considerably cheaper than sills, joists, plank and tar paper.

It has the further advantage of tending to equalize the uneven surface of the ground. Most of our cement is placed in storage during the winter months and it is extremely hard to get a good bearing for a plank floor on uneven ground that is frozen. This matter is very much simplified by the use of straw. The superintendent assures me that although storm water ran under the shed to a depth of 6 in. on this project, not a sack of cement was lost.

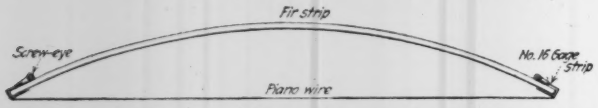
In loading a floor of this character, the loading should commence at the center and proceed outward. Straw will compress under weight of the cement and if the sacks are piled in the center first, the tiers will assume sufficient batter to prevent overturning.

The salvage value of the straw is small but if pouring is continued into cold weather it can be used to cover the freshly laid concrete to prevent freezing.

Improved Concrete Road Straight Edge

By R. L. Hufford,
Resident Engineer, Iowa Highway Commission, Ames, Iowa

THE ORDINARY wooden straight edge used to test the concrete wearing surface of pavements during the finishing process has some disadvantages, chief of which are: That it is heavy and unwieldy; it does not



SIMPLE, STABLE STRAIGHT EDGE FOR CONCRETE ROADS

retain its true and accurate edge after some use; and it marks the green concrete surface which requires re-belting. The straight edge shown here overcomes these faults, is cheaper, and lasts longer than a wooden one.

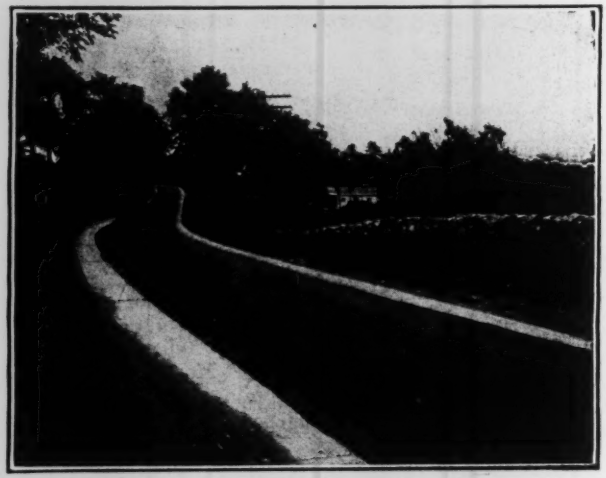
A strip of fir 1½ in. x ¾ in. and 10½ ft. long is shod on each end with a strip of 16-gage sheet iron into each of which strips a shallow groove has been filed to receive the wire. A No. 16 piano wire is secured to each end of the strip by screw-eyes set in the wood. The fir strip is bent like a rainbow sufficiently to keep the piano wire in tension. This assembly is then mounted on a handle for testing the surface at the center of the slab.

Due to its light weight, this straight edge is found to be especially advantageous on wide city work.

Concrete Shoulders Widen Highway and Increase Its Visibility

By F. A. Gardner
Assistant Engineer, New Hampshire Highway Department, Concord, N. H.

DURING the past four years motor vehicle traffic in New Hampshire has increased nearly 300 per cent, and unfortunately many of the trunk-line highways



WIDENED ROAD IN NEW HAMPSHIRE

which were built prior to this period are proving to be of insufficient width to care for the increasing traffic.

The state highway engineers faced with these facts and a knowledge of the high cost of reconstruction, have solved the problem to their own satisfaction by the construction of concrete shoulders adjacent to the present metal road surfaces. The marginal strips of reinforced-concrete not only add to the width of the present highways, but they serve as a factor of safety in night driving, as they are readily seen on the darkest nights, and minimize the danger from dazzling headlights. They also help to reduce the mainenance costs, for they require but little attention and are not as expensive to mainain as earth or gravel shoulders.

The accompanying illustration, showing a section of the Daniel Webster Highway at Nashua, New Hampshire, is a good example of this type of reconstruction. This highway carries 25 per cent of the total state motor-vehicle traffic, and at this particular point an 18-ft. metallic surface of modified asphalt was widened to 24 ft. by the addition of 3-ft. reinforced-concrete shoulders. Here the life of the original construction has been prolonged, and the road sufficiently widened with a modern type of construction so as to withstand both present day and future traffic.

From Job and Office

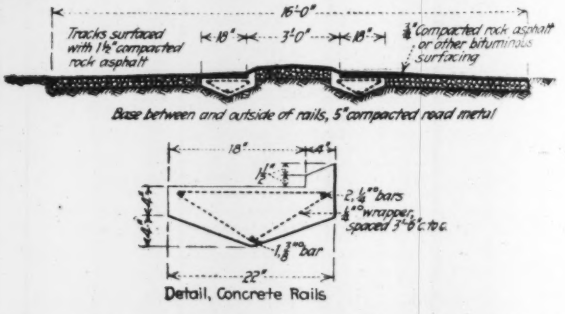
Hints that Cut Cost and Time

Experimental Road in Kentucky Has Reinforced-Concrete Rails

By J. T. Madison
Assistant Engineer
Department of State Roads and Highways, Frankfort, Ky.

AN EXPERIMENTAL length of road recently built by the Department of State Roads and Highways of Kentucky consists mainly in two 18-in. reinforced-concrete rails of a maximum depth of 8 in. laid 4½ ft. apart center to center. Between these rails and outside of them to the curb is laid 5 in. of compacted road metal surfaced with ¾ in. of either rock asphalt or other bituminous surfacing. The rails themselves have 1½ in. of bituminous covering.

This road, called the invisible track road, is a new design recently introduced by S. B. Moore. Since the type was special and special machinery would be needed for its construction, Mr. Moore hit upon the plan of using a timber runway in such a manner that the roller, when compacting the higher portion of the roadway, would compact the rock asphalt and the tracks themselves. This timber runway for the road roller was built with 2-in. pieces laid longitudinally on the same centers as the reinforced-concrete rails embedded in the road. Laterally upon this planking were fastened other 2-in. material upon which the road roller itself operated.



Detail, Concrete Rails

For this type of road an estimate of quantities per mile of 16-ft. road includes 380 cu.yd. of concrete and about 11,500 lb. of reinforcing steel, and 1,015 cu.yd. of compacted metal in place.

From Job and Office

For Contractor and Engineer

Road Building: Adapting Proved Principles To Local Conditions

By C. N. Conner
Construction Engineer
North Carolina State Highway Department, Raleigh, N. C.

BESIDES building roads of the higher type of surfacing such as concrete, concrete base with black top, or penetration macadam, where heavy traffic and industrial conditions indicate such construction, North Carolina is taking advantage of local materials for road construction in many of the remote and thinly-populated sections of the state. These lighter and less costly types of construction, particularly adaptable in the South where frost conditions are seldom a serious menace, are explained in the following paragraphs:

The first (Fig. 1) is a top-soil, or sand-clay, road which, with proper maintenance and drainage, will carry from 400 to 1,000 vehicles per day. In Fig. 2 is shown a road of local creek gravel which, besides gravel, contains quite a large percentage of poor quality sand, mica and silt, but when compacted makes a very good roadway in all seasons of the year. Its surface will require careful maintenance and the addition of new material from time to time.

Fig. 3 shows a waterbound macadam with surface treatment. The best local stone available was used in the construction of this surfacing. It is poor in quality compared with good limestone but after being compacted (it will not bind) and protected by a surface treatment of tar or asphalt and chips it is carrying comfortably and safely all local and through traffic. A fourth type is a top-soil road which takes a veneer treatment. This treatment consists of about 3 in. of broken stone partly rolled into the surface of top-soil road and then finished as a penetration macadam. A section of a top-soil road thus treated has carried all traffic between towns of about 30,000 population each for a period of two years without any signs of failure. We also build a roadway which consists of a marl base with a wearing surface of sheet asphalt. The base course consists of marl as taken from the pit with coarser and harder portions crushed to a 3-in. size. This is deposited on the subgrade, shaped and rolled. It then sets very much like a lean mix of concrete. By itself it does not make a satisfactory wearing surface as the heavy traffic creates pot holes and dusts up the surface. The sheet asphalt, however, gives a satisfactory top course and is substantially supported by the dense marl base course beneath.

FOUR TYPES OF NORTH CAROLINA ROAD MADE FROM LOCAL MATERIALS
Fig. 1—Top-soil or sand-clay road. Fig. 2—Highway built of local creek gravel. Fig. 3—Surface-treated waterbound macadam. Fig. 4—Sand-asphalt highway in coastal plain.

Some sections of the coastal plain are a mass of sand, there being nothing else available for road building; and the cost of aggregates for concrete roadway is prohibitive. A very satisfactory road (Fig. 4) is being constructed with a base course 3½ in. thick, using 93 per cent local sand and 7 per cent bitumen, and a 1½-in. top course of wearing surface of 79 per cent sand, 10 per cent filler, 11 per cent bitumen. Local sand only is used, the filler and bitumen being shipped in. This type is being constructed at a cost of less than one-half that of the higher-type roads and has carried all traffic for two years.

The use of local materials, when proper principles of drainage and maintenance are observed has undoubtedly proven a success in North Carolina.

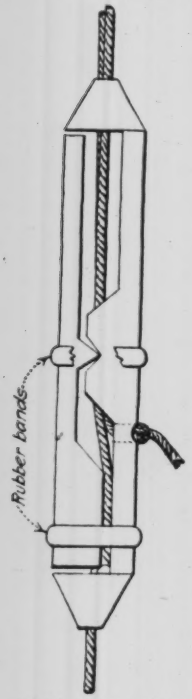
From Job and Office

Hints that Cut Cost and Time

Adjusting Device for Plumb Bob

BY W. C. WEST,
County Road Commission, Alpena, Mich.

PICTURED herewith is a plummet adjusting device that any transit man can make in an otherwise idle hour after luncheon in the woods or in camp at night. The only materials required are a twig about ⅛ in. in diameter, preferably one with a slender pith in it, and two thread rubber bands. The only equipment needed is a good sharp knife. The principle upon which this device is made is simply that of the common spring clothespin. However, the plummet line needs to be run through both ends of one member in order to have it work smoothly. The short member should be of the same diameter as the long one, hence the piece of twig selected should be straight and a little more than twice the length of the finished job. An effective hook for threading the adjuster is easily made from a common brass pin by catching the point under a screwdriver or knife blade, bending it to shape.



PLUMMET LINE ADJUSTER

Performance Data of Highway Service Automobile Equipment

BY EDWIN S. AUSTIN
Missouri State Highway Department, Jefferson City, Mo.

MISSOURI has made good use of a large part of the equipment furnished by the War Department from the surplus remaining after the World War. The trucks supplied by the department are in use in the maintenance of the state roads. There are 114 counties in the state and through these counties the highway department is constructing a system of roads aggregating about 7,600 mi. The maintenance of these roads before and after construction has been partially solved by the government equipment.

In order that the expense could be properly allocated to the different divisions, the maintenance department of the state highway commission has caused to be kept an accurate record of costs on this equipment. This includes a large number of passenger automobiles in use by the commission purchased outside.

The figures on the attached table are from the record that has been kept since the system was inaugurated, a period of about eight months to Dec. 1, 1923.

The table shows the number of vehicles and the number of months they were in use. The total mileage of all the cars and the average mileage for each; the cost per mile for lubricator and gasoline as well.

OPERATION COST MOTOR VEHICLES, 1923: MISSOURI HIGHWAY DEPARTMENT

Make	No. Vehicles	No. Months Used	Total Miles Run	Miles Per Month Each	Cost Per Mile: Gas	Oil	Repairs	Grease	Tires	Misc.	Total Cost: Per Month	Per Mile
TRUCKS												
Liberty	122	457	155,234	341.8	$0.016	$0.012	$0.01	$0.002	$0.001	$0.002	$45.98	$0.135
Denby	1	1	173	173.0	.061	.013	.104	.004	.....	.....	31.58	.182
Velie	5	17	3,468	203.5	.103	.019	04	.004	.....	.004	31.07	.172
Packard	6	26	6,498	249.9	.776	.017	.024	.002	.....	.005	32.12	.128
Pierce-Arrow	2	3	1,797	575.6	.079	01	.0008	.001	.....	.....	32.60	.091
Kelly	3	14	4,779	341.3	.08	.015	.008	.001	.001	.....	36.02	.105
Nash Quad	5	24	5,772	240.5	.127	.021	.014	.01	.001	.002	42.47	.176
Oldsmobile	7	27	19,368	717.3	.022	.002	.0067	.0004	.0027	.0027	27.21	.037
Service	1	5	2,040	408.0	.042	.007	.108	.002	.0008	.024	78.06	19
F. W. D.	2	9	3,205	356.1	.107	.006	.002	.002	.0001	.....	42.37	.116
White	1	3	2,805	935.0	.028	.007	.053	.....	.....	.....	82.68	.088
G. M. C.	2	7	4,686	669.4	.024	.006	.017	.0005	.053	.004	71.20	.106
Wilson	1	3	850	283.3	.058	.006	.....	.003	.124	.....	54.66	.192
I. H. C.	1	2	78	39.0	.145	.024	.138	.....	.....	.....	12.03	.308
Dodge	1	5	1,880	376.0	.029	.007	.118	.0006	.082	.003	89.91	.239
Mack	1	3	1,637	545.6	.099	.036	.....	.....	.....	.....	73.91	.135
Ford	85	341	201,166	589.9	.021	.003	.004	.0004	.009	.003	25.20	.042
Total	247	948	415,981	438.7	.058	.007	.009	.001	.006	.0026	37.85	.086
PASSENGER CARS												
Oldsmobile	10	82	133,564	1,628.8	$0.0133	$0.0013	$0.0121	$0.0004	$0.0101	$0.0026	65.36	.0401
Star	2	12	11,692	974.3	0106	0021	0126	0001	0052	0012	31.11	.0319
Dodge	26	240	300,070	1,250.2	0172	0027	0210	0005	0134	0048	72.01	.0573
Ford	137	829	758,953	915.5	0142	0027	0142	0003	0097	0067	38.35	.0405
Total	175	1,163	1,201,279	1,035.4	.0143	.0025	.0149	.0003	.0106	.0042	47.13	.0455
MOTORCYCLES												
H-D	10	36	11,752	326.4	$0.009	$0.005	$0.024	$0.0001	$0.007	$0.003	16.48	.05
TRACTORS												
Holt 10-T.	4	9	1,059	177.6	$0.430	$0.13	$0.10	$0.035	.....	.....	83.61	.71
Holt 5-T.	3	5	574	114.8	.175	03	.214	.002	.....	.....	48.79	.425
I. H. C.	14	42	10,178	242.3	.07	.02	.005	.0006	.....	.0006	23.84	98
Fordson	24	96	17,778	185.1	.106	.028	.015	.001	.....	.003	28.94	156
Total	45	152	29,589	194.6	.107	.029	.018	.002	.....	.002	31.42	161
Grand total, all vehicles	477	2,299	1,661,601	722.7	$0.026	$0.004	$0.0012	$0.007	$0.009	$0.003	41.79	$0.051

From Job and Office

For Contractor and Engineer

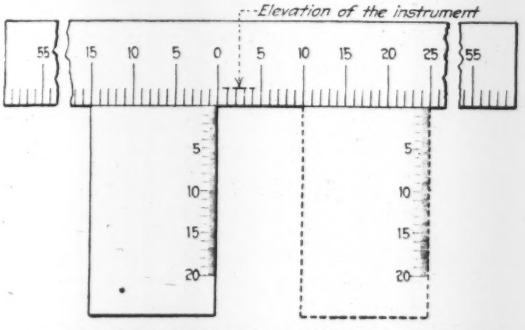
Simple Scale Saves Time in Plotting Cross-Section Notes

By C. D. Buck
Chief Engineer, Delaware Highway Department, Dover, Delaware

A PLATTING scale as shown in the accompanying cut is one of the most efficient time savers used in the office of the Delaware State Highway Department. The use of such a scale eliminates the reduction of original and final cross-section notes, besides cutting in half the possibilities of errors and number of operations.

The horizontal scale, representing distances to right and left of the center line, is placed on the elevation of the instrument, as given in the notes; the draftsman slides the small vertical scale along the face of the horizontal scale to the graduation representing the distance from the center line and plats the rod reading direct from the notebook.

The construction of the platting scale is very simple. A steel straight-edge is graduated to represent the



SCALE FOR PLOTTING CROSS-SECTION NOTES

distance to the right and left of the center line to conform to the cross-section paper used by the department.

For the small vertical scale, a white celluloid graduated to feet and tenths is most satisfactory.

Progress Book Holds Road Data

By Edward E. Reed,
Assistant State Highway Engineer, Trenton, N. J.

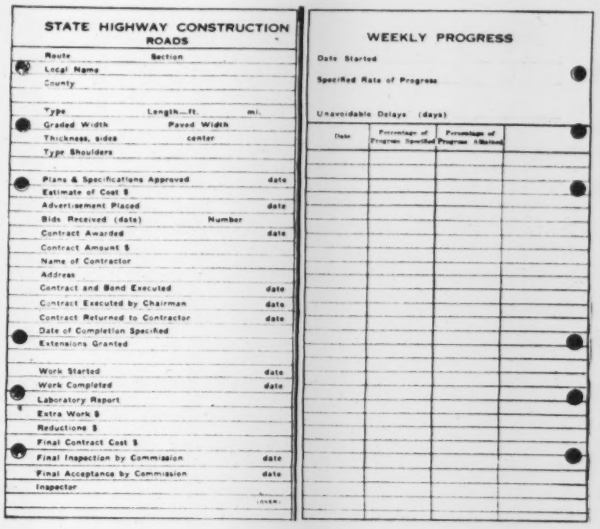
WHEN ROAD and bridge construction contracts are few in number it is a simple matter to remember the essential details of each one. When the number increases, as it has done in New Jersey as a result of a $40,000,000 bond issue, it was found necessary to compile a progress book.

The chief utility of this pocket size loose-leaf book is memory assistance, but beyond even that it serves as a remarkably concise collection of essential facts always on hand for ready reference.

On an inspection trip, writing a letter, meeting a delegation of interested citizens, compiling percentage of work accomplished, comparing costs—in all these cases, the progress book comes in handy, saving time and supplying accurate information.

The information is obtained originally from contracts. From week to week construction reports supply the number of working days and progress percentages.

The edition is limited to two copies, leather bound.



SAMPLE SHEETS FROM ROAD PROGRESS BOOK

Very likely roads could be built without the aid of this book, but, like air in a tire, it saves many a bump.

Job and Office Notes

Every City Engineer Has Experienced considerable difficulty in keeping accurate record of underground structures. House laterals to sewers have to be laid to each vacant lot when paving is commenced and it always has been difficult to find an inspector for such work who can take proper measurements and keep proper notes, writes D. H. Fleming, city engineer of Owen Sound, Ontario.

To overcome this difficulty the following method was employed by Mr. Fleming:

The curb finisher was supplied with a brass stamp of the letter "S" 2 in. high. When the curb was sufficiently set to take a good impression a sunken "S" was stamped on the top surface over each sewer lateral. This scheme stops all possible errors and provides a permanent practical record always on the job.

Computing Quantities of Earthwork on roads, railroads and dams very often requires finding the end areas of a large number of "three level" cross-sections. It is always a tedious repetition of solutions of the same problem. The most usual solution analyzes the figure into four triangles to be combined and solved together each time.

The solution here shown, and suggested by George C. Love, Newport News, Va., admits the combined solution of two triangles, afterward subtracting a known constant quantity to get the result.

Stated as a rule it is: Add the side distances. Multiply the sum by the sum of center depth and a constant predetermined depth. Divide by 2 and subtract the constant substractive area. The work is then two simple additions, one multiplication, one division and one subtraction.

The method is by no means new or original but deserves to be used more for its convenience.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Bridge Design for Maintenance

Sir—A certain large bridge consisting of several plate girder spans and truss spans was recently turned over to me for maintenance. The first thing I noticed when coming to paint it was the lack of forethought on the part of the designers in regard to maintenance. The water both from the sidewalk and roadway drained down on the bottom chord, and on the plate-girder spans the end floorbeams were so close together that it was next to impossible to clean out the rubbish from between them, let alone paint them. The bottom chords did not have cover plates over them but a cast-steel grating.

Most bridges that I have had to do with have been thoroughly protected along these lines, and have gone a number of years without needing paint. The above bridge is new and the bottom chord was in bad shape. I write to call designers' attention to these details.

Waterford, N. Y., Dec. 24, 1923. OSCAR HASBROUCK.

Computing Maximum Runoff from Scanty Data

Sir—I am much interested in "Flood Flows or Maximum Runoff of Montana Streams," by George Henry Ellis, in *Engineering News-Record*, Dec. 20, 1923, p. 1016. Mr. Ellis's warning that "considerable judgment must be used in basing estimates on data," such as he quotes, is well taken.

Having had an experience of fifty years in determining the probable necessary size of openings for culverts and small and large bridges, I feel constrained to join Mr. Ellis in cautioning young engineers not to regard the fixing of the capacity of such structures as an exact engineering science. Drainage areas and their slopes, character of soils, amount of forestation, maximum rainfall and its duration, are all factors that should be determined from the most reliable data. But with all such available data collected and studied, there remains a grave uncertainty to be reckoned with, especially in a comparatively new section of country. There is no such thing as a dependable "high water mark." What are called such, are merely the highest point known or believed to have been reached. Such marks are no guarantee whatever that they may not be overlapped at any time, when certain conditions obtain.

In the case of our western mountains—given a heavy snowfall, a late spring, warm continued rains, perhaps a Chinook wind, and the whole mass of snow let loose practically at once—no formula which can be made from ordinary data will apply. I have known an average of 8 ft. of fairly hard packed snow in the Cascades mountains to go inside of forty-eight hours. In one winter of my railroad experience, there was an accumulated fall on the summit of 148 ft. 10 in. and at one time we had and operated trains through cuttings of 22 ft. of snow packed nearly as hard as ice.

Personal testimony of settlers along the banks of streams as to high water is unreliable. In my younger days I established the grade line and built a small bridge the deck of which was 5 ft. above the highest water ever known, as reported by a settler who himself, and his father before him, had lived sixty years nearby. Before track reached the bridge, water ran 6 ft. over the ties. The bridge luckily stood but the house did not, and this not in a snow country, but in Texas.

In an old, well-known country, where nature's freaks are better known, closer figuring may possibly be permissible, but when temporary bridgework—timber structures—must of necessity be employed, I often used a formula—I guess it was—in which, after I had inserted all the values deduced from the best data I could get, I multiplied the figured area by three. This may not have been engineering in its technical sense, but I proved its value many a time, and in any case it is better in such works if one must make a mistake to make it the safe way. JOHN F. STEVENS.

New York City,
Jan. 3, 1924.

Standard Highway Bridge Specifications

Sir—I have read with interest the editorials in your issue of Nov. 22, 1923, entitled "Art and Craftsmanship" and "Highway Bridge Troubles." In both I think you miss the main idea. In the former article you seem to confuse standard plans with standard specifications. None of the committees has any intention of preparing any standard plans. Standard specifications have been shown to be so useful, both here and abroad, that I fail to see how any experienced engineer can quarrel with the idea, however much he may object to individual items in any particular specification. It is well known that in any case they must be revised from time to time in response to the progress of the arts and sciences. Highway bridges are public structures and must be designed and constructed or at least approved by public officials, who are thus made to an important extent custodians of the lives of the traveling public.

My idea is that standard design specifications are intended principally to establish criteria by which public officials and others can judge as to the safety and economy of any designs by whomsoever submitted. There is no intention of barring out engineers in private practice from designing public highway bridges, but they bar themselves out of the design of the small bridges, which are vastly more numerous, involve greater aggregate outlay and are fully as important so far as public safety is concerned as the large ones.

There are a number of engineers in private practice in this country who could safely be given *carte blanche* to design and construct any given proposed bridge, but there are a large number of others who could not.

Regarding your second editorial mentioned above, I would say that practically all the troubles mentioned are with bridges built before the advent of heavy automobile traffic, and public officials, or at least state highway officials, are fully as familiar with these troubles as anybody, and are spending immense sums of money to eliminate them, but the task is colossal and takes time and money. When these troubles are eliminated, doubtless other conditions will arise requiring still further alterations and reconstruction.

E. E. BRANDOW, Bridge Engineer,
Pennsylvania Department of Highways.

Harrisburg, Dec. 17.

Responsibility for Timber Treating Inspection

Sir—Replying to the letter on the above subject in *Engineering News-Record* of Nov. 15, p. 816, the inspection bureaus are employed to inspect and be sure that the treating companies are furnishing material and performing the treating work strictly in accordance with the specifications. Therefore, the inspection bureaus should be not only morally responsible but also financially responsible for any defective material inspected by them going into construction work. Otherwise, why are they employed and what are they for? It frequently happens that representatives of the inspection bureaus are inexperienced in handling the inspection of the raw product and the preservative treatment of the wood, but this in no way should relieve the responsibility of the treating companies who furnish the material.

Our plant superintendents are made responsible for all material treated and shipped from the treating plants, regardless of inspection, and should any material, after it leaves our treating plants, prove defective it will be replaced free of cost. The treating plant management should be responsible regardless of inspection bureau service.

Pittsburgh, Pa. GRANT B. SHIPLEY.
Dec. 31, 1923. Century Wood Preserving Co.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

Specifications Are Now About completed for the new international bridge at Bridgeburg, Ont., over the Niagara River. They call for a double-track structure with driveways and walks.

The Newly Appointed City Planning Commission of Jacksonville, Fla., has organized with F. P. Deering as chairman and George W. Simonds, Jr., as secretary. Mr. Simonds is chief sanitary engineer of the Florida State Board of Health.

On the Indiana Board for Registration of professional engineers and land surveyors Governor McCray has reappointed Harvey Mitchell Anthony, of Muncie, and H. M. Bell, of Logansport, to new and three-year terms. Mr. Anthony is chairman. The board was created by the 1921 legislature.

The 4,000-Mile Railroad across the continent of Australia will be completed in 1925, according to an announcement to the effect that the closing link, 95 miles long, is now under construction. The line runs from the city of Perth on the West Coast to the town of Cairns on the East Coast.

At the Request of the Governors of Colorado and New Mexico to the President, Secretary Hoover has been appointed by President Coolidge to represent the federal government on a commission for the formulation of a compact to fix the rights of the United States and the States of Colorado and New Mexico in the use, control, and disposition of the waters of the Rio Grande.

Announcement Has Been Made by Mayor-elect Kendrick of Philadelphia of the appointment of George H. Biles as director of the department of public works in the new city administration which took office on Jan. 7, 1924. Mr. Biles has been connected with the state highway department of Pennsylvania for eighteen years. He resigned from the position of deputy commissioner of highways in March, 1923, when the highway department was reorganized. He was acting head of the department from Jan. 1922 to March, 1923.

With the Idea of Instituting condemnation proceedings, the Board of Supervisors of San Francisco has petitioned the State Railroad Commission to place valuations on the power distributing properties of the Pacific Gas & Electric Co. and of the Great Western Power Co. so that the city can acquire these properties for the distribution of Hetch Hetchy hydro-electric power. The two exhibits which accompany the resolution setting forth the various units of the power distribution system which the city wishes to acquire includes all the property of both concerns, except the steam heating plant of the Great Western Power Co. and the bay cable crossing of the Pacific Gas & Electric Co.

Reclamation Advisers To Leave Jan. 15 for Western Trip

The Special Advisers on Reclamation expect to leave Washington Jan. 15 on a visit to practically all of the reclamation projects. Since most of the stops will be for one day's hearing only, it will be necessary for the water users to condense greatly any testimony which they wish to present. The Commission, however, has no more time at its disposal and is making this trip largely for the purpose of checking certain deductions which have been made from the very complete detailed data which have been at their disposal.

Clifford Older, Illinois Highway Engineer, Resigns

Clifford Older, chief engineer of the Illinois State Highway Department, has resigned to enter private practice. For more than 17 years he has been connected with the department, coming to the department first in 1906, being made bridge engineer in 1906. He served in that capacity through two administrations and part of the third until Governor Frank O. Lowden appointed him chief engineer in 1917. After graduation from the University of Wisconsin in 1900 Mr. Older's early experience was in railroad work with the Pennsylvania, the Wabash Pittsburgh Terminal and the Chicago & Alton. Here he handled track elevation, maintenance of way, tunnel construction, improvement of line and grade, railroad water supply systems and other work incidental to railroad construction and maintenance.

As bridge engineer in the Illinois Highway Department Mr. Older materially raised the standard of highway bridge design and construction, but his largest work has been the direction of the engineering incidental to carrying out the Illinois paving program, one of the largest ever undertaken. At the same time he has personally planned and directed the comprehensive series of highway research activities in connection with the Bates Test Road. This monumental piece of research has attracted world-wide attention and the conclusions have led to fundamental changes in paving practice, far reaching in their effect on the cost of construction and durability. Mr. Older has probably done as much, if not more, than any other highway engineer by combining research, theory and practice to put hard-road design on a sound analytical and technical basis.

After Feb. 1, or as soon as his successor has been appointed, Mr. Older will devote his time to the Consoer Engineering Co., Chicago, the firm name being changed to Consoer, Older & Quinlan. This firm, of which Mr. Older has been president for some time past, has a general engineering practice specializing in the design and construction of water supply, sewerage and drainage systems, paving and bridges and industrial developments.

Boston Engineers Protest Removal of A. P. Davis

Resolutions protesting against the removal of Arthur P. Davis from the position of director of the U. S. Reclamation Service by Secretary of the Interior Hubert Work were adopted by the Council of the Affiliated Technical Societies of Boston on Dec. 28, as follows:

"WHEREAS, The Honorable Hubert Work, Secretary of the Interior, has in effect dismissed Arthur P. Davis, former Director of the U. S. Reclamation Service, by abolishing the office of Director; and has immediately thereafter re-created the position under another name and appointed to it a man of little, if any, engineering training or experience in the work involved; and

"WHEREAS, Arthur P. Davis has made a splendid record for himself and the Service and is widely known and respected among engineers, for his ability, integrity and competency as an engineer and as an administrator; and

"WHEREAS this change in directors is believed to be detrimental to the best interests of the Government and to the esprit-de-corps of the Service; and

"WHEREAS the methods used by the Secretary of the Interior to accomplish his purpose are objectionable, and imply that partisan politics rather than fair merits controlled action;

"*Be It Resolved* by the Council of the AFFILIATED TECHNICAL SOCIETIES OF BOSTON, representing a body of more than 3,000 engineers,

"*That* it deplores the removal of Arthur P. Davis and condemns the method employed as being against the public good; and

"*That* copies of this resolution be forwarded to the President of the United States; to the Secretary of the Interior of the United States; to the Commissioner of Civil Service of the United States; and to the Senators and Representatives from Massachusetts; and be printed in the bulletin of the Affiliated Technical Societies of Boston.

Two Grade Separations Ordered by Public Service Commission

The New York State Public Service Commission has ordered the elimination of the Winton Road crossing the New York Central tracks in Rochester, N. Y., by the depression of Winton Road under the railroad tracks. The cost of the work is estimated to be $460,000, of which one-half is to be paid by the railroad, one-quarter by Rochester, and one-quarter by the state.

The commission has also ordered that Willowdale Ave. in Port Washington, Long Island, be carried over the Long Island R.R. tracks on an overhead bridge to consist of a four-span concrete structure with a 24-ft. roadway and a 5-ft. wall. The cost of the work is to be paid for by the railroad company and the township of North Hempstead.

Engineering Employment Prospects Bright

Indications Point to Better Year Than Last, Is Belief of A.A.E. Employment Secretary

All indications point to 1924 as being a better year for engineers than 1923 was. Even a shortage of technical men during the first months of the year with salary advances of from 16 to 20 per cent is predicted by E. B. Miller, employment secretary of the American Association of Engineers. Practically no unemployment among engineers existed in 1923 and with the many large construction projects going ahead the slight over-supply in the last months of the year will soon be absorbed.

The present demand for designers on all classes of work but especially architectural and structural engineers, states Mr. Miller, exceeds the supply. He adds the following:

The demand for 1924 will be for specialists on construction, particularly factory and residence buildings, hydro-electric, power houses and drainage projects. A very good demand can be expected in the highway and municipal field, inasmuch as several states have fairly large programs set for the coming year. This year will see the railroad professional engineer in greater demand than he has been for the past decade. Railroads are contemplating considerable construction work and there is much maintenance work that must be done. Electrical authorities state that the electrical field is active.

Activity in the West

Surveying engineering employment for different sections of the country, the Middle West will probably be the most active as far west as Utah. In Utah the outlook is better than it has been for many years. Outside capital is carrying on investigation for the development of natural resources. The Utah Power & Light Co. is contemplating the construction of a $10,000,000 hydro-electric unit. Coal properties will be opened and possibly a new steel plant constructed. Irrigation and highway construction will be active in that locality. The far Northwest will be rather dull until after the middle of April, but several large projects are contemplated, including the project for the Long-Bell Lumber Co.—a city and lumber manufacturing center. Considerable highway construction is under way in California, and the volume of building and utility construction, which are mainly engineering projects, continue actively. The Southwest has been rather dull and may continue to be that way for a few months. Some little work is contemplated, but not on any great scale. The mid-continent oil fields will experience a healthy demand for technical men for the coming season. Large engineering projects in the central states are contemplated in all localities, including general building, highway and municipal work which will create an acute demand for technical men. The Southeast has been fairly active in engineering work and promises a continuance of this activity, while the Northeast has been quiet, work slowing down and a number of men unemployed at the end of the year, but the outlook in the Northeast for coming spring work is good.

Index Title Pages Available

Title pages to the index of Volume 91 of *Engineering News-Record* are now available. They may be secured by addressing the "Index Editor" of this journal.

Philadelphia Engineers Discuss Economy in Fuel

The Engineers' Club of Philadelphia will hold a conference on Tuesday, Jan. 15, 1924, on "Economy in the Use of Fuel." There will be morning, afternoon, and evening sessions. Treatment of the subject is to be confined strictly to economy, engineering and financial phases, avoiding the commercial phase of competitive fuel-saving devices. Papers will be presented by engineers recognized as authorities in the various phases of the subject, and will cover use of coal by railroads, by public utilities and manufacturing industries, in metallurgical processes, and in domestic use.

Frank C. Jordan Nominated for President A. W. A.

The nominating committee of the American Water Works Association has announced the following ticket to fill the offices of the association for 1924-25: President, Frank C. Jordan, Indianapolis; vice-president, Harry F. Huy, Buffalo, N. Y.; treasurer (present incumbent), William W. Brush, New York City; trustees, District No. 3, Edgar H. Hoopes, Jr., Wilmington, Del., and District No. 3, J. Arthur Jensen, Minneapolis. Additional nominations for any office may be made by sending the secretary a written request to that effect, signed by twenty-five members. If there are no such requests then the nominees will be certified as elected, without letter ballot.

Many Special Trains Arranged for Road Convention Visitors

All indications point to a record-breaking attendance at the convention and road show of the American Road Builders' Association at Chicago Jan. 14-18. In various sections of the country special trains and special cars are being arranged for by groups of men identified with the highway industry who are planning to attend in a body. The highway builders of North Carolina will travel to Chicago on the "Frank Page Special," which leaves Raleigh Jan. 12 at 11:30 p.m.

The New Jersey contractors and engineers will go out in special cars which will be attached to the "Pennsylvania Limited," leaving New York at 11:05 a.m. Jan. 13.

A group of public officials and contractors from Florida are arrranging for a special car on the "Dixie Flyer" leaving Jacksonville at 9 p.m. on Jan. 12; and an all-Denver car will bring the delegates from that city.

Other groups of delegates in various cities are making similar arrangements, and information in regard to them can be obtained from local railway offices.

The official headquarters of the American Road Builders' Association will be at the Congress Hotel and C. M. Upham, convention and show manager, will be in general charge.

Ontario Hydro Commission May Develop St. Lawrence

Sir Adam Beck, chairman of the Ontario Hydro-electric Power Commission, has laid before the Canadian Federal Government a proposal for St. Lawrence power development. The scheme includes a dam, control works and power house at Morrisburg, Ontario, to cost between $75,000,000 and $80,000,000. At this is an international power site New York State would be expected to bear half the expense and would receive half of the 350,000 hp developed. The plan calls for the Canadian Federal Government to pay $15,000,000 of Ontario's share of the cost of the project in compensation for the water control facilities.

Sir Adam Beck also proposes the construction of a high voltage line from Ottawa to Morrisburg and from one of these points to Toronto in order to tie up the St. Lawrence system with the Niagar system and to tie in the future developments of the Ottawa River which will produce from 300,000 to 400,000 hp.

The Ontario Hydroelectric Power Commission also expects to ask the Ontario Government for an appropriation of from $10,000,000 to $12,000,000 to install a large steam plant on Lake Ontario or Lake Erie to augment the Niagara system in carrying peak loads.

Concrete Institute Nominates

In the report of the nominating committee of the American Concrete Institute made public recently, A. E. Lindau, vice-president and general manager of the Corrugated Bar Co., has been nominated for president, and M. M. Upson, vice-president of the Raymond Concrete Pile Co., as vice-president of the Institute. Other officers nominated are: director, first district, C. E. Nichols; second district, E. D. Boyer; sixth district, Arthur Bent; treasurer, Harvey Whipple. W. A. Slater is chairman of the nominating committee.

According to the constitution, the list of candidates is submitted thirty days before the annual convention to the members of the Institute for letter ballot and and ballots are canvassed at noon on the second day of the convention. The convention in 1924 is to be held at the Drake Hotel, Chicago, Feb. 25-28.

During the annual meeting there will be a symposium covering about a dozen different departments of concrete work, reviewing the developments in each and suggesting possibilities for future development. The program will be made more effective by an exhibit showing models, pictures, drawings and samples of concrete, the progress in all of the departments of concrete work covered by the symposium. The assignments for this symposium are as follows: Richard L. Humphrey, presentor of the general outline; A. N. Johnson, concrete roads; John J. Early, architectural concrete; A. E. Lindau, bridges; Duff A. Abrams, making good concrete; A. N. Talbot, engineering research; M. M. Upson, piles and waterfront; Albert Kahn, reinforced-concrete buildings; F. W. Kelley, cement manufacture; A. P. Davis, dams, tunnels, conduits, and culverts; A. W. Ransome, mechanical equipment, and R. F. Havlik, concrete products.

State Highway Department of Michigan Reorganized

Frank F. Rogers, Michigan State Highway Commissioner, has announced the reorganization of the state highway department effective Jan. 1. The reorganization plan makes a radical change in the field organization of the Department and more definitely defines the various responsibilities of the executive heads of divisions.

In the field organization the district plan is abandoned and in place of the state being divided into eight districts with permanent district officers, the state is divided into five subdivisions for general supervision in charge of five supervising engineers who will work out of the main office in Lansing. These men will have general supervision of all highway activities in their several sections and will furnish the contract between the executive heads at Lansing and the resident engineers in the field. In the place of temporary residencies being established on each construction project, there will be permanent ones which will include from two to four counties each.

G. C. Dillman, deputy commissioner, has been made deputy commissioner and chief engineer. F. D. Fitzgerald, office manager, has been made business manager. The duties of municipal and landscape engineer have been combined with the duties of road engineer and the division placed in charge of C. F. Boehler. C. A. Melick continues as bridge engineer. B. C. Tiney, who was until recently assistant maintenance engineer and has been chief inspecting engineer, has been made maintenance engineer. The division of surveys and plans is continued under the direction of H. L. Brightman. The position of contract engineer, held by F. D. Messenger, has been abandoned, and a new division of materials and equipment created under his direction. J. H. Bateman, director of the highway testing laboratory, at the University of Michigan, continues in his capacity.

The following men who have previously been district engineers are made supervising engineers of the following sections: Southwestern Michigan, C. E. Foster, with headquarters at Grand Rapids; Southeastern Michigan, C. M. Zeigler, with headquarters at Lansing; Northeastern Michigan, V. R. Burton, with headquarters at Bay City; Northwestern Michigan, W. J. Kingscott, with headquarters at Cadillac; and Upper Peninsula, H. I. Davies, with headquarters at Escanaba.

The appointment of the permanent resident engineers and other field and office positions will be announced later.

Recapture Clause Sustained by Supreme Court

The United States Supreme Court has declared that the so-called recapture clauses of the Transportation Act are constitutional. These clauses require the railroads to turn over to the government one-half of their earnings in excess of 6 per cent of their valuation and to place the other half in a reserve fund. The test case was carried to the Supreme Court by a small railroad in Texas, the Dayton, Goose Creek Ry. but this road was supported by 19 of the larger railroads in the country as they were vitally interested in having the clauses declared unconstitutional.

Propose Extending N. Y. Rapid Transit System to New Jersey

After a conference with the North Jersey Rapid Transit Commission the New York State Transit Commission has announced that it is considering plans to extend the local tracks of the New York rapid transit lines from their present terminals at South Ferry and City Hall under the Hudson River to New Jersey. In New Jersey these lines will connect with a loop system to be built by the North Jersey Commission well back of the waterfront where it can have interchange stations with the New Jersey suburban railroad lines. The two commissions hope that such an arrangement will not only improve the commuting service in New Jersey but will also reduce the empty car movement in the opposite direction to rush-hour traffic in the New York subways by making it possible to operate the trains around the New Jersey loop.

Incinerator at Charleston, Not Wheeling, W. Va.

In the news story on p. 1074, of our issue of Dec. 27, relating to the acceptance of the first Balmer type of incinerator to be built in this country, the location of the plant was wrongly given as Wheeling, W. Va., whereas it should have been Charleston, W. Va. The same slip of the pen was made in the editorial entitled "Chances in Garbage Disposal," published on p. 1042 of the same issue.

Dredge Starts Work at Entrance to San Francisco Bay

Work has started on dredging a deep channel across the bar at the entrance to San Francisco Bay directly opposite the Golden Gate. The present depth of 33 ft. on the bar has been considered insufficient, and in rough weather large vessels use one of the deep but tortuous channels along the coast to the north or to the south. The bar is being dredged by the Engineering Corps dredge "Culebra," which is to make a channel 40 ft. deep across the 2,000-ft. width of the bar. The work is being done under the direction of Col. Herbert Deakyne, Engineer Corps, U. S. A. stationed at San Francisco.

New Power Development on the Upper Mississippi

The Minnesota Power & Light Co. has purchased the plant of the Little Falls Water Power Co., Little Falls, Minn., including power rights on the Mississippi River at Blanchard's Rapids, near Little Falls. The company plans to develop the Blanchard's Rapids site immediately by the construction of a hydro-electric power plant with an initial installation of 18,000 hp. and an ultimate installation of 27,000 hp. The new plant will be connected with the present hydro-electric plant of the Water Power Co. in Little Falls and to the Minnesota Power & Light Co.'s present system at Nashwauk, Minn., by a high tension transmission line.

Railroad Drawbridge Floated with Aid of 4-Ft. Tide

IN RESPONSE to the demand of shipping interests desiring to improve the accessibility of the dredged channel in the Oakland estuary the U. S. War Department, recently ordered the removal of the Harrison street drawbridge owned by the Southern Pacific Co. and spanning the estuary between Oakland and Alameda, Calif. The time set for removing the bridge was Dec. 27, although on that day the tide rise was only about 4 ft. The swing span, 334 ft. long and weighing about 400 tons, was floated on barges and hauled into a slip nearby for dismantling. The channel was blocked by this operation for less than an hour. The bridge was involved in a collision with a steamer four years ago, (*Engineering News-Record*, April 22, 1920, p. 829.) Service over the bridge was discontinued in the early morning hours; at low tide five barges filled with water were floated into place beneath it and cribbing was used to wedge the barges against the bottom chords. As the tide came in the barges were pumped out by floating pile-driving equipment moored alongside. At 11 a.m. the bridge floated off its pier, the channel was closed to traffic, and by means of tow lines the floated structure was warped to previously prepared moorings nearby. The floated bridge supported on barges with pile drivers moored alongside made an unwieldy bulk to maneuver between dolphins and piers but the move was effected without difficulty. In addition to the two driver winches a line from the dredge at the slip was used as were two small gasoline tugs. A larger steam tug standing by for emergency service was not required. The work was done by the Southern Pacific Co's. own forces.

Random Lines

A Professional Labor Saving Device

Sir—Referring to the "hot dog engineer" whose modest shop you depicted in this column (Aug. 30, 1923), the writer has just been privileged to take out a patent for a hot dog sandwich machine, invented by an engineer employed by the Eli Bridge Co. See Patent No. 1,471,727, Oct. 22, 1923.

F. M. D.

* * *

Erudition Personified

Extract from an application for employment received by a New York construction equipment house:

Sir—Can I interest you in my veritable desire to make a life-time connection with some good, progressive, optimistic organization?

I enjoy excellent health, possess a good education, and a character commanding superlative business and social references. When young, I deliberately migrated around the country explicitly to broaden myself mentally and develop some practical activities for my technical erudition; and was actively engaged during my itineration as a tool and die maker, work inspector, bench assembly sheet metal department foreman, lathe and milling machine department foreman, and toolroom foreman.

Later I was a mechanical equipment appraisal engineer, functioning my duties throughout the United States and Canada, in sundry manufacturing industries. The proper functioning of this position demanded an extensive practice of the art of visualization, which gained me a fund of valuable empiric information, tending to broaden one's scope of mind.

I don't know it all, and certainly thank God for providing me with a personality that appreciates special or experienced knowledge from any source, instead of one copious with egotism and sophistication.

I have worked and studied assiduously to attain the positions I have held, and would repeat the effort tenaciously if given an opportunity.

* * *

The New Year's Crop

Printing Engineers—The R. R. Donnelley & Sons Co., of Chicago.

Financial Engineer—The title given by the Fort Worth *Record* to a well known railroad consulting engineer of New York, who doubtless would disclaim the appellation and therefore is permitted to remain anonymous.

Furniture Engineer—Some one who visited Tampa, Fla., and prompted the Tampa *Times* to editorialize on the prospects of the industry he represented settling in the West Florida metropolis.

Photographic Engineers—Peyser & Patzig, New York City.

Work Starts on Diamond Creek Project in Arizona

In order to comply with the permit granted by the state of Arizona Dec. 26, 1922, and which was valid only if construction started within a year, J. B. Girand on Dec. 18 started construction work on what is known as the Diamond Creek power project. Diamond Creek is a tributary of the Colorado river which it enters about 100 miles above the Boulder Canyon dam site. It is estimated that a total of 200,000 hp. can be developed here with a dam 300 ft. high.

The Federal Power Commission has refused a permit for the construction of this project and no report could be secured as to the extent of the work which was started to comply with the Arizona permit requirement.

Two Penstock Accidents Within Week in California

While the penstock of the newly completed Eldorado hydro-electric plant on the American River in California was being filled for the first time a break occurred near the power house, without serious damage except to the pipe itself. Where the rupture occurred the penstock consists of 30-in. lapwelded pipe in 20-ft. sections. The rupture was 6 ft. long, about 16 or 18 in. from a longitudinal weld and parallel thereto. The pressure of escaping water under a head of about 1,800 ft. forced the break open to a width of about a foot. A new section is being substituted, while further study of the cause of the break is being made.

On Jan. 1 after shutting down the Big Creek No. 8 of the Southern California Edison Co., the penstock burst. The escaping waters caused the death of two women. The cause of this break could not be learned as this issue goes to press. This also is a welded pipe; it is the penstock in which a previous break occurred, described in *Engineering News-Record*, Oct. 20, 1921, p. 640.

Preliminary Bridge Plans Made for Philadelphia Subway

Preliminary design drawings have been filed with the Art Jury of Philadelphia by the Department of City Transit for the bridge that will carry the subway lines from Chestnut and Walnut Sts. across the Schuykill River. The bridge will be a four-track structure, and will be located at Sansom St., which is between Walnut and Chestnut Sts. Difficult engineering problems are involved in its design because of the close clearances afforded, and because the tracks from Walnut St. go into subway on both sides. The Chestnut St. tracks are in subway on the east side, but become surface lines at the western side of the bridge. The bridge is planned as a steel arch structure of three arches, one of which spans the river and the other two of which span the railroad tracks on each side. Loans for transit development which include this bridge were approved at the November election, but the funds will not become available until about March, 1924. It is expected that detail drawings will be prepared after the design has been approved by the Art Jury, and that work may be started early in Spring.

Illinois Sanitary Units Form Association

First Annual Gathering of Nine Districts Held in Chicago Jan. 4 and 5

The first annual meeting of the Illinois Association of Sanitary District Trustees was held Jan. 4 and 5 in Chicago. The organization is composed of the officials and representatives of the nine sanitary districts of the state, Chicago, North Shore, Bloomington-Normal, Decatur, Downers Grove, Elgin, El Paso, Taylorville and Urbana-Champaign. W. C. Field, Decatur, was the first president and G. H. Radebaugh, Urbana-Champaign, secretary. The purpose of the association is "the promotion of a better understanding of collection and disposal of domestic and industrial sewage. To offer assistance to communities contemplating projects of sewage collection and disposal."

While the major portion of the time was devoted to an inspection of the Calumet and Maywood plants in Chicago and the newly constructed plants of the North Shore District, talks on control of operation were made by F. W. Mohlman and W. D. Hatfield. The former indicated the different laboratory controls essential for each of the different methods of disposal and different processes. As coarse screens, grit chambers and fine screens usually affect less than 5 per cent removal of organic matter, little laboratory control is utilized. For all other processes the bio-chemical oxygen demand is of the first consideration but for the biological processes of sprinkling filters and activated-sludge tanks nitrogen fixation must be noted; for filters to see that they are not overloaded and for the sludge tanks to see that the air applied is sufficient. Mr. Hatfield emphasized laboratory and technical control, particularly popularizing the necessity of efficient control. Not 10 per cent of the plants in the state are properly operated, the remainder of the plants being substantially a financial loss to the taxpayer, was Mr. Hatfield's opinion.

Value of Publicity

G. H. Radebaugh, manager, Urbana-Champaign District, spoke on "Publicity and Its Relation to Sanitary Districts." Four times in the life of getting a district under way publicity is needed: When district is formed; time for voting on bonds; during construction, and when ready to operate. Newspapers and pamphlets are the media he used effectively. The best mailing list is the water-bill list. School children asked parents to vote the day of elections. Editors were taken to see works and all became boosters. The vote was 3 to 1 in favor of the issue and only one of thirty private owners received more than $1 for right-of-way easements.

A resolution indorsing the position of the Chicago Sanitary District in asking 10,000 sec.ft. of diversion from Lake Michigan was ordered sent to Illinois senators and congressmen.

The officers elected for the ensuing years are as follows:

W. C. Field, president; W. J. Allen, vice-president, and G. H. Radebaugh, Urbana-Champaign, secretary.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROADBUILDERS' ASSOCIATION, New York City; Annual Convention, Chicago, Jan. 14-18, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York, Jan. 16-18, 1924.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Chicago, Ill., Jan. 21-24, 1924.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Montreal, Jan. 22, and Ottawa, Jan. 23, 24, 1924.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting (20th anniversary), Chicago, Ill., Feb. 25-28, 1924.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, March 11-13, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-21, 1924.

The New York Section of the American Water Works Association will be joined at luncheon on Jan. 17 by the Sanitary Section of the American Society of Civil Engineers. Luncheon will be served at the Hotel Pennsylvania, at 12:30, and will be followed by an address by George W. Fuller on "Practice of Double Filtration of Water in Europe."

The Engineers' Society of Western Pennsylvania will hold its annual banquet Jan. 28, 1924, at the William Penn Hotel, Pittsburgh. The speakers will be Elisha Lee, vice-president of the Pennsylvania R.R. Co., F. I. Kent, vice-president, Bankers Trust Co., and Strickland W. Gillilan, humorist.

The Texas Section of the American Society of Civil Engineers will hold its spring meeting in Brownsville, Texas, about March 20, 1924, as announced by Secretary E. N. Noyes of Dallas. Special attention will be given to papers on water conservation and control. The first issue of the *Texas Engineer*, the new organ of the Texas Section, is off the press.

Personal Notes

COL. WALTER W. CROSBY, former chief engineer for the Maryland State Highway Department, has been appointed location engineer for the department. Colonel Crosby was the one who originally organized the department. Until recently he was in charge of Grand Canyon National Park.

DOUGLAS SPRAGUE and CHESTER A. SLOCUM, consulting engineers, announce the removal of their office from 167 West 13th St., New York City, to 50 East 41st St., New York.

HENRY E. EHLERS, formerly assistant chief engineer for the Public Service Commission of Pennsylvania, has been appointed director of the Department of City Transit in the new Philadelphia city administration, which took office Jan. 7, 1924. This department will have charge of the construction of the comprehensive system of subways for which money was provided at the November election. Mr. Ehlers had been connected with the Public Service Commission for ten years.

V. C. HALPIN, assistant engineer of the Missouri Pacific R.R. at Little Rock, Ark., has been appointed division engineer at Monroe, La., to succeed W. P. Hayes, promoted to trainmaster. C. A. Hewes, assistant engineer on the Kansas City Terminal Division, succeeds Mr. Halpin at Little Rock.

W. W. PATCH, division engineer of the California Highway Commission with headquarters in Los Angeles, resigned Jan. 1 to enter real estate business in Santa Monica in connection with consulting engineering work. Mr. Patch is a graduate of the Massachusetts Institute of Technology, at one time was assistant engineer for the New York Aqueduct Commission and from 1905 to 1913 was construction and project engineer for the U. S. Reclamation Service. During the nine years in which he has been in charge of state highway construction in Division 7, work in this district has totaled more than $12,000,000 in value. S. V. CORTELYOU, assistant to Mr. Patch, will be acting division engineer pending the appointment of a successor.

R. H. OBER and JOSEPH JACOBS announce that they have formed the firm of Jacobs & Ober, consulting engineers, with offices in the Thompson Building, Seattle, Wash., for general engineering practice in irrigation, water power, dams, water-works, sewerage systems, river and harbor improvements and other general engineering work.

HAROLD W. BAKER, previously engineer of the Bureau of Municipal Research, Rochester, N. Y., has been appointed commissioner of public works in that city.

L. C. SPRAGUE, who has been superintendent of the Uintah Railway Co. since July 1, has been appointed acting general manager to succeed Major James E. Hood, whose death occurred Dec. 16, 1923, from injuries received in an accident on the road, as reported in these columns last week.

CHARLES MACDONALD, LL.D., civil engineer of New York, formerly of Gananoque, Ont., has presented an engineering library to Queen's University, Kingston, Ont.

ARTHUR SURVEYER, E. G. ACRES, ARTHUR AMES and JOHN MURPHY, of Montreal, have been appointed joint vice-presidents of the management committee organized in connection with the representation of Canada at the World Power Conference to be held in London next summer.

W. E. HALL, a hydraulic engineer on the staff of the U. S. Geological Survey, has accepted the position of secretary-treasurer of Western North Carolina, Inc., an organization devoted to the study and development of the natural resources of western North Carolina. He will remain district engineer for the Survey until E. D. BURCHARD, to succeed him as district engineer, can be transferred from Hawaii.

R. C. PARSONS, who has been a resident engineer on construction for the Kentucky State Highway Department, is to be the locating engineer on the new Appalachian & Western North Carolina R.R., the general plans for which were described in *Engineering News-Record*, Nov. 29, 1923, p. 878.

S. H. LEA, formerly district road engineer in Morgan County, West Virginia, has been appointed an assistant engineer for construction and maintenance of highways by the Pennsylvania State Highway Department.

BRUCE E. THOMAS, civil engineer, formerly associated with Arnold Rosch & Hartline, civil engineers, New Philadelphia, Ohio, has joined the organization of the Charleston-Dunbar Natural Gas Co. and will be located at Dunbar, W. Va.

EDWARD G. SHEIBLEY, formerly in charge of the bureau of housing and sanitation for the City of Los Angeles, has resigned that position to become chief engineer and superintendent of the department of safety of the California Industrial Accident Commission, with headquarters at San Francisco.

LYONS MUSSINA, city engineer for Williamsport, Pa., was re-elected for the second term at the annual reorganization meeting of the city council. Prior to serving as engineer he had been assistant city engineer.

FRED LAVIS, consulting railway engineer, New York City, has been selected to give a series of lectures at Princeton University during January on the Economics of Transportation and Railway Engineering. The lecture will include world transportation, and the development of American interest in the foreign field, as well as an outline of the economics affecting railway design. They will be given under the William P. Field Engineering Lectureship Foundation in the John C. Green School of Engineering.

Obituary

HARRY H. JONTZ, maintenance-of-way engineer in Texas for the Missouri, Kansas & Texas R.R., died suddenly at his home in Dallas, Dec. 20 at the age of 37 years. Mr. Jontz was an engineering graduate of the University of Kansas. He entered the services of the Katy System thirteen years ago as draftsman, and was in turn office engineer at Parsons, district engineer at Sedalia, and then engineer of maintenance-of-way north of the Red River. Since 1922 he has been engineer of maintenance-of-way for the whole system.

DALE T. WADSWORTH, structural engineer, died at the Suburban Hospital, Bellevue, Pa., Dec. 20, 1923, at the age of 36 years. Mr. Wadsworth at the time of his death was employed by the Koppers Co. of Pittsburgh, Pa., in the coal and coke department as a designing engineer. He was a graduate of the American Bridge Co. School of Apprentices, Ambridge, Pa., and had spent some time in Ohio as chief draftsman of the Oregonia Bridge Works, at Lebanon, Ohio.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Design of Road-Building and Other Equipment Shows Advance in 1923—Part II

IN LAST week's issue (p. 36) appeared the introduction and Part I of *Engineering News-Record's* Annual Review of Machinery and Materials. Part II, presented herewith the week before the Good Roads Show in Chicago, deals with equipment and materials used primarily for road-building work and with miscellaneous products not discussed under any of the specific classifications in Part I:

Among the outstanding developments of the year in road-making machinery were the increase in the use of tractor-operated outfits, the speeding up of the charging and discharging operations of paving mixers, the design of a great variety of snow plows, and the use, by contractors, of standard rather than special plant. Manufacturers have increased the bearing area of steel road forms to prevent sagging and the consequent formation of waves in the finished pavement surface. The increased use of light trucks for road material transport is reflected in the development of a new turntable of small size. Measurement and loading of bulk cement for batches is made possible by a machine of fairly recent design which supplements the operations of batch-measuring devices for sand and stone.

For city paving work attention has been given in the design of mixers to decreasing the clearance height so that the paver may pass under crossings, wires and other overhead structures. Caterpillar traction continues to be popular as the mounting for paving mixers and some manufacturers of these large, self-contained plants have added materially to the strength of their working parts. Crawler design has been altered to prevent cutting of asphalt pavements.

Some of the newer finishing machines for concrete roads are fitted with a vertical adjustment of the strike-off to take care of sub-base for brick or two-course work with steel reinforcement.

In the field of industrial haulage narrow-gage gasoline locomotive improvements consisted in varied speed ranges and also the adaptation of the Fordson tractor to narrow-gage track work. A wide variety of motor-truck bodies particularly adapted to road-building was put on the market last year.

Road Graders

Increased use of tractor haulage has necessitated a strengthening of road-grading equipment to withstand the heavier pulls and greater strains involved, as compared with team haulage. The Western Wheeled Scraper Co., for example, has redesigned its standard elevating grader especially to meet the requirements of tractor operation. The machine has been equipped with an improved front bolster, a new hitch, and an improved disk. The elevator has been entirely redesigned in the interests of simplified adjustment.

The back-sloper attachment for road graders, J. D. Adams & Co. have found, has grown so in popularity that it has been adapted to all sizes of the company's graders. This has meant a revision of the strength and weight of these machines to adapt them to the use of back-slopers. An accessory was introduced last year in the form of blade extensions, useful both for road maintenance and snow removal work. These extensions increase the blade length 50 per cent, or from 12 to 18 ft.

A light rooting tool, known as the "graderooter," for use in conjunction with a subgrader in preparing the final surface, was brought out by Lakewood; it is designed for operation by a 10-ton tractor. A new feature of the company's subgrader was the provision of a framework to carry scarifying teeth, enabling the equipment to perform a twofold function.

In the Baker-Maney self-loading scraper the introduction of a cast-steel tongue has increased the strength and facilitated the haulage of the scrapers when used in trains of three to six behind heavy tractors. A new heavy cast-steel bolster also was introduced, superseding the previous goose-neck frame construction.

> ***High Spots in Year's Progress***
>
> *One of the year's chief developments was the increased use of tractor-operated outfits for road construction.*
>
> *Paving-mixer operation was speeded up, road forms made more rigid and snow plows of many types designed for use on tractors or trucks.*

Incorporated in a Fordson tractor a one-man road grader, adaptable also to snow removal work, was developed by the Wehr Co. To this machine may be attached also scarifying teeth located just ahead of the blade.

For use with the "Pup" road maintainer and roller, the Austin-Western Road Machinery Co. placed on the market a number of adjustable blades which can be raised or lowered by the operator without leaving his seat.

In its automatic subgrader and strike-off the Heltzel Steel Form & Iron Co. has provided an adjustable truss so arranged that the crown in the strike-off may be increased or decreased as desired. The grader blades are attached on an arc conforming to this crown.

Several forms of blade grader for attachment to motor trucks are now on the market, including the Root spring scraper.

Paving Mixers

In the paving mixer field the most important event of the year was the agreement reached by contractors and manufacturers upon three standard sizes (21-E, 13-E, and 7-E). Fundamentals of design remained unchanged, although there was a movement toward increasing strength and ruggedness, due largely to equipment with larger power units. In the case of the Ransome 21-E paver, the 15- or 20-hp. steam engine of the past has been replaced by a 40-hp. gasoline engine. This additional power, in turn, has called for a strengthening of all transmission parts. In addition, the capacity of the drum has been enlarged to 30 cu.ft., water measurement, to make possible working at capacity on steep inclines.

Much thought has also been given to speeding up the receiving and discharge operations of the mixer and to the arrangement of levers to simplify the duties of the operator. The speeding up of charging and discharging, according to the Ransome claim, allows a batch to be put through the mixer every 75 sec. while retaining materials in the drum a full minute.

Other paving-mixer details involve improvements in water-tanks. On the Smith paver the new tank took the form of an open-top trough pivoted within a water-tight outer shell. For the water-tank on the Koehring paver a three-way balance valve was designed for automatic operation by the movement of the charging skip. Another change on the latter machine, particularly for municipal work, was the introduction of a low headframe for reducing clearance height; 3 ft. is saved by this design.

On the Chain-Belt paver the new features are inclosed traction transmission running in oil and fully inclosed power discharge made up of cut gears. With this machine, it is claimed, a batch can be handled, exclusive of

mixing time, in 10 sec. For the Jaeger No. 14-P mixer a complete Fordson tractor is installed as the power unit, while the 7-cu.ft. Mixermobile, of the Milwaukee Concrete Mixer Co., is mounted on a Ford touring car chassis.

Road Forms

Steel forms for concrete-road construction have not been materially changed by the Blaw-Knox Co., although the bearing area of the lock joint plate supporting two adjacent forms has been increased to prevent sagging during the passage of the finishing machine. With the more rigid construction depressions in the finished concrete surface are prevented, thus eliminating impact due to the passage of heavy trucks at high speeds. The striking of road forms was speeded up by the development of a form-puller, as distinguished from a stake-puller. It consists of a pair of hinges connected to wooden levers on a steel base. These hinges are attached to the top flanges of the form and pressure on the lever pulls an entire 10-ft. section with its three stakes.

An increase to 12 ft. in the length of section of the Carr road form was made by Lakewood to reduce handling and setting costs. This particular form has a curved or "line-point" surface on which concrete cannot lodge and interfere with the operation of the finishing machine, so that a smooth surface in the completed pavement is produced. A wedge lock makes the strength of the joints almost equal to that of the main section.

Concrete Finishing Machines

The latest type of Heltzel concrete road finishing machine may be used either as a power or a hand-operated rig. The strike-off is raised by eccentrics and also has a lateral motion from 4 to 8 in. The tamp may be operated to strike either a hard or a soft blow and each side of the finisher is fitted with controls so that the operator never has to run back and forth. The strike-off, tamp, and belt may be operated independently or simultaneously.

A new feature of the Lakewood finishing machine is a vertical adjustment of the strike-off which permits the striking off of concrete not only at the height of the form but at a maximum of 4 in. below the top to form a subbase for brick or block surfacing or two-course work with steel reinforcement.

Industrial Haulage

Gasoline Locomotives—Wider ranges of speed than were common several years ago are found in the modern narrow-gage gasoline locomotive. The newer models are characterized by great compactness, inclosure of the working mechanism, and low center of gravity to avoid derailment when operating on curved or uneven track. The 4- and 7-ton Plymouth locomotives of the Fate-Root-Heath Co. have a four-speed range of 2¾, 4, 8, and 12 miles per hour; a long main drive chain is eliminated by substitution of an additional gear in the transmission. The final drive is by a very short heavy chain direct from sprockets on the transmission to each axle. Only those gears that are actually transmitting power are in mesh.

A standard design for all gages and models from 3½ to 15 tons was announced during the year by the Milwaukee Locomotive Manufacturing Co. These machines also have four speeds and the transmission is of the jaw clutch and gear type, with gears always in mesh. A new feature of this equipment is the mounting of the brake drum on the drive shaft of the transmission, thus eliminating braking on the wheels. This change, it is claimed, results in fewer parts without sacrificing braking efficiency.

On two models of gasoline locomotive, the Brookville and the Whitcomb, Fordson tractors have been installed as the power unit. The latest Brookville model has a four-wheel drive with Ford truck power unit altered by the installation of an auxiliary reverse, making possible working speeds of 3 and 8 miles per hour both forward and backward.

Road Show Report

"Engineering News-Record" is sending two of its editors, C. S. Hill and R. K. Tomlin, Jr., to cover the Road Show and Convention in Chicago next week.

Watch for their reports in the Jan. 24 issue.

For road maintenance the Austin "Pup" may be used not only as a light roller, but also as a tractor for carrying grading blades. This equipment is powered by a Fordson tractor.

* * *

Motor Trucks and Bodies—While a number of detailed improvements have been made in the design of motor trucks, fundamentals have remained the same during 1923. In the Mack truck, for example, the changes affect the cooling system, spring suspension, engine lubrication, and drive system, which, the manufacturers point out, are refinements in design and in no sense innovations. The Autocar Co. extended its line last year by adding an electric truck to its gasoline models.

A great variety of special bodies for motor trucks is available for road builders. In the design of truck bodies manufacturers have introduced improvements which facilitate the mechanical operation of dumping and allow the material to slide out rapidly. On the Van Dorn body, for example, ⅜-in. steel plate is used throughout and all corners are rounded. A special locking device restricts the opening of the tailgate for the spreading of the load. In the Jiffy twin-duty dump-body for a Ford chassis a low loading height is secured and pivot supports equalize the load without straining the rear axle.

For handling light trucks on road construction, a new turntable occupying only 6½ ft. of space was brought out by Blaw-Knox; it is designed especially for trucks of 1 and 1½ tons capacity.

* * *

Wagons and Cars—A heavier batch-box car, 1 ft. longer than its former model and holding two 37-ft. boxes, was manufactured by the Western Wheeled Scraper Co. The same maker also installed an extension apron on its automatic dump car designed especially to discharge materials beyond the ballast on a railroad track. A platform dump body designed especially for a Ford 1-ton truck was among the offerings of the Eagle Wagon Works; it may be equipped with box sides and double-acting automatic tailgate or rack stake sides.

Snow Removal Equipment

Plows—Motor vehicle traffic is now demanding routes which can be used every day in the year. This condition has emphasized the importance of removing snow from highways, and as a result manufacturers have developed a great variety of equipment for this purpose. As a rule, snow-removal apparatus consists of plows of the straight-blade, V-shape, or rotary types, operated either by a tractor or a motor truck. The simpler type of equipment is represented by the straight-blade plows designed for attachment to the front end of tractors and manufactured by the Baker Manufacturing Co., ths Good Roads Machinery Co., and others. Among the V-shaped plows are the Walsh, Stark, Champion, Baker, LaPlant-Choate, Monarch, Martin, and others. Among the rotary snow plows on the market are the Monarch, Dallmann, and Snow King.

The straight-blade plows differ in various details, particularly in the height and shape of the mold-board, but all have adjustments for varying the cutting angle and in some cases the blades are fitted with hinged lower sections which trip back when they hit an obstruction, thereby saving the blade from damage. Most of the V-shaped plows may be adjusted for various widths of cut. Both the Monarch and the Snow King rotaries involve the use of V-shaped plows with revolving vanes, one on each side, which cast the furrows of snow well out to the sides of the road. The Dallmann plow is in the form of a scoop with a single revolving fan or propeller.

A rotating broom type of snow plow, the Fox, has been developed recently. It is designed for attachment to the front end of a motor truck and sweeps, instead of plows, a path through the snow.

* * *

Loader—A number of changes have been made by the Barber-Greene Co. in its elevating bucket loader to adapt this equipment to the handling of snow from piles into trucks.

Loaders and Conveyors

For its heavy-duty bucket elevators, designed for capacities up to 700 tons per hour, the Jeffrey Manufacturing Co. devised a new bushed knuckle chain for which claims of great durability are made. A bucket may be removed without disturbing the chain. The company also developed a self-propelled bag stacker, consisting of a carriage supporting an inclined boom reaching to a height of 25 ft. and capable of handling 500 bags per hour. For its belt conveyor installation the Jeffrey company adopted a high-pressure lubricating system for the idler pulleys.

A wider operating range was given to the Robins portable belt conveyor by the introduction of two new machines having lengths of 30 and 35 ft., respectively, as compared with the 20- and 25-ft. lengths on the older types. Another new feature of the company's conveying belt equipment is the use of idlers with Timken roller bearings and Alemite pressure lubricating fittings.

For coal, the Barber-Greene Co. developed a loader mounted on crawlers.

A coal feeder also was placed on the market designed for unloading drop-bottom railway cars. A Haiss loader model was equipped with a Fordson tractor power plant. On the larger, heavier machines operated by gasoline engine, improvements included a wider feeding element, heavier traction drive chain, new swivel spout and measuring hopper.

Last year the Dorr Co. put on the market a rotary type conveyor for handling wet or semi-dry solids. It consists of a spiral scoop feeder and a horizontal pipe with longitudinal rims to keep the material broken up and moving.

Portable Pumps and Compressors

Efforts to make contractors' portable equipment tamperproof were recorded by several manufacturers who inclosed their machines in steel housings, instead of canvas curtains. The new Sullivan gasoline-engine driven, portable air compressor, with a capacity of 170 cu.ft. of free air per minute, was announced during the year. It is mounted on a four-wheel truck with rubber-tired wheels and springs, and is equipped with the improved "wafer" type of air valve characterized by low clearance losses.

For contractors, public service corporations, etc., a mobile compressor unit on rubber-tired wheels was developed by the Ingersoll-Rand Co.; it is driven by a four-cylinder gasoline engine and is available in a number of sizes to meet operating requirements for a variety of pneumatic tools, such as jackhamers, paving breakers, clay diggers, tie tampers, and drills. In the new Schramm engines and air compressors lubrication is improved by the use of an oil wick for oiling the crank pins and connecting-rod bearings. Among the new lines of contractors' portable pumping plants is a Barnes quadruplex unit with an output of 60 gal. per minute at 500 lb. per square inch pressure; this outfit is intended primarily for supplying water to road-building work.

In its new 18-in. sand and gravel dredging pump, the Erie Pump & Engine Works has produced a machine driven by a 500-hp. Diesel engine. It handles 9,500 gal. per minute of sand and water, including about 300 cu.yd. of sand per hour, and operates against a maximum head of 95 ft. including friction head in 1,650 ft. of 18-in. discharge pipe line. The pump has a low horizontal discharge so that the outlet pipe can be placed on the ground or on pontoons without the special supports needed when the discharge is from the upper part of the pump shell.

Surveying and Drafting Equipment

For mine and tunnel work new Brandis levels and transits were designed, in which the optical systems are characterized by low magnification and large fields, resulting in clear, well defined images under conditions of poor visibility. A new monitor plane-table alidade was announced by Berger. New telescopes were incorporated in Gurley transits last year and the truss standard was modified to increase its rigidity. A convertible transit-level having a telescope of increased magnifying power was put on the market by Aloe.

Outstanding improvements in drafting-room equipment included the Pease blueprint dryer with thermostatic control capable of drying 8 ft. of print per minute and also a high-power electric arc lamp for fast blueprinting. To its guide and pens for lettering drawings the Wood-Regan Co. added a number of new sizes.

Cement and Asphalt

Portland cement production and shipments during 1923 attained new high records. While the Geological Survey's figures for December are not available at this writing the production for 11 months of last year was 126,969,000 bbl., as against a total of 114,789,984 bbl. for the 12 months of 1922. It is probable that the 1923 production exceeds 135,000,000 bbl.

For the asphalt industry the year 1923 also established a new record. The tonnage for paving purposes—1,140,000—exceeds by 20 per cent the 1922 figures. Last year's tonnage is equivalent, according to the Asphalt Association's estimate, to 114,000,000 sq.yd. of paving.

Unclassified Equipment and Materials

In so far as possible the equipment and materials dealt with in this Review have been grouped according to a number of general classifications. The following notes cover products not covered by any of the classes previously considered:

A submarine type of pile-driving hammer was designed by the McKiernan-Terry Drill Co. which does away with the need of a follower. To facilitate its operation under water compressed air is piped into the bottom cylinder of the hammer and a hose carries the exhaust to the surface. Advantages claimed for the hammer are the feasibility of using shorter piles than is otherwise possible, elimination of sawing off under water, and accurate alignment of the piles.

Water-bearing fissures in rock or cracks in masonry are now being sealed by the Weber intrusion method in which grout or plastic compounds of special consistency are introduced by a compressed-air injector.

For sealing gasoline tanks and preventing loss by evaporation the Wiggins floating steel roof has been developed by the Chicago Bridge & Iron Works.

A new portable spray painting equipment is offered by the Spray Engineering Co. It is a lightweight outfit of the pressure type designed for painting areas not large enough to warrant the use of heavier equipment. The total weight is 130 lb. with motor-driven, and 135 lb. with engine-driven, compressors.

For acetylene welding and cutting a new portable Milburn generator was designed to obviate the use of high pressure cylinders; it holds 30 lb. of carbide, equivalent to 150 cu.ft. of cylinder gas.

A new portable asphalt plant, with a capacity of 1,800 yd. a day, was announced by the East Iron & Machine Co. It is equipped with oil burners under both the drum and the boiler. An electric motor drive is employed for the entire plant instead of steam. Warren Bros. Co. also put on the market a 2,000-sq.yd. portable road asphalt plant of the oil-burning type.

As a result of adopting steel frames and crowns for its rock crushers the Smith Engineering Works are now selling this equipment with a two-year guarantee against breakage, even by tramp iron.

A self-contained, portable screening, crushing and loading plant with a capacity of from 300 to 600 cu.yd. a day and weighing 28,500 lb., was placed on the market by the Russell Grader Manufacturing Co.

Designed to splice lumber for shoring, scaffolding and bracing the Pyle-Rogers timber clamp of steel, weighing only 6 lb., operates on a toggle principle and requires only a few seconds to place or dismantle.

Two improvements in Fenestra reversible ventilator windows for schools and office buildings were a new framing section, providing a flat steel line against which plaster may be finished, and a swing-in ventilator at the sill.

In its "aggrementer" for batch measurement of concrete aggregates, the Erie Steel Construction Co. introduced improvements enlarging the reclaimers to take care of material struck off in leveling the measuring boxes and reducing the time needed to erect and dismantle the plant.

To make possible the movement of steel wall form plates in unit groups the Metal Forms Corp. perfected an aligner clamp. With this equipment on one job 104 standard 24 x 24-in. wall form units were moved in a single lift.

Business Notes

National Paving Brick Manufacturers' Association will hold its annual meeting in Cincinnati Jan. 22 and 23. It is planned to have group or sectional meetings during the afternoon of the first day, at which time all of the owners and administrative officers of the companies will meet by themselves, all the salesmen and territorial association men having their own meeting, and all the superintendents and operating managers meeting separately to discuss their particular problems.

Building Products Co., Toledo, has purchased from the Hodges-Edelman Co., Cincinnati, the patents and good will of the Hodges adjustable shore, and has bought a factory in Toledo to manufacture this equipment on an increased scale.

Selflock Nut & Bolt Co., Inc., East Syracuse, N. Y., manufacturer of friction fit nuts and bolts, has entered into a contract with the Bethlehem Steel Co. for the manufacture and sale of carriage and machine bolts, track bolts and heavy railway nuts and bolts. The Selflock company will increase its own facilities and specialize on S.A.E. Selflock products as well as cap screws with Selflock threads.

Petroleum Iron Works Co., Sharon, Pa., announces the shipment, within two weeks, of three solid trainloads of steel-plate products for central Texas oil fields, involving a tonnage of 6,000 and 150 cars. The tonnage included in the first trainload was fabricated and shipped within three days from the receipt of the order and arrived at its destination in 120 hours despite a delay of 24 hours in Ohio.

Business Side of Construction

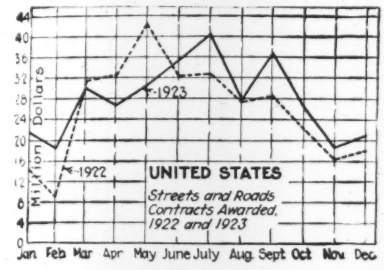
FACTS AND EVENTS THAT AFFECT COST AND VOLUME

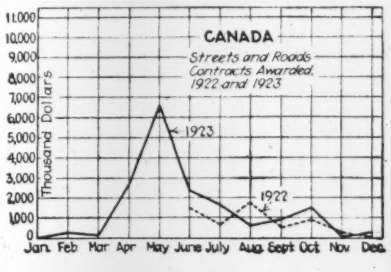
Volume and Trend of Road Work in Last Six Years Compared with 1913

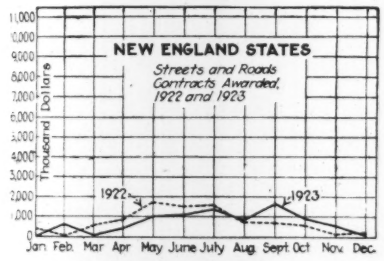
Statistics from *Engineering News-Record* covering awards of $25,000 and over for streets and roads show that this work has been fairly active in all parts of the country for the last six years. The chart covering the entire United States for the years 1922 and 1923 shows them following the same general trend. The three peaks for the year 1923 coming in March, July and September are due to the work done in three sections: West of the Mississippi, Middle Atlantic and Middle West. The money expended in those peak months in these sections was $12,860,000, $12,202,000 and $9,962,000, respectively.

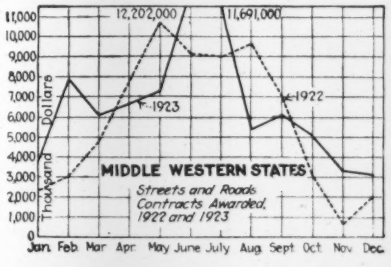
During 1922 there were 2,267 awards with a total value of $334,694,000 and an average of $147,600, compared with 1923 with 2,351 projects totaling $361,837,000 and averaging $153,900.

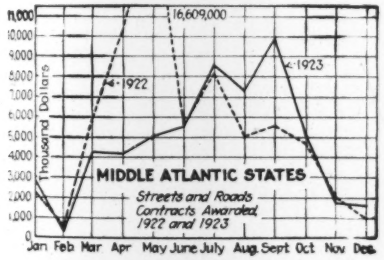
The trend of work on streets and roads may be seen by the tabulation of the totals for the last six years compared with 1913. The actual physical volume in terms of 1913 cost is given in the last column. It is obtained by applying the *E. N.-R.* Construction Cost Index Number.

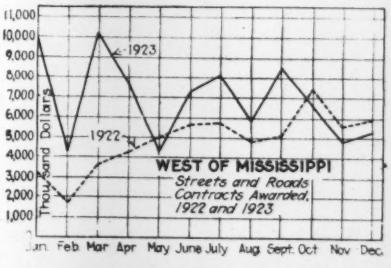


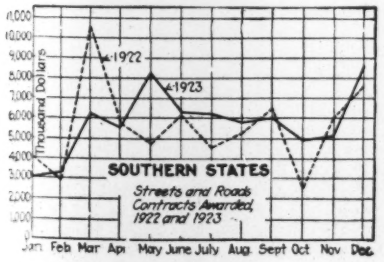


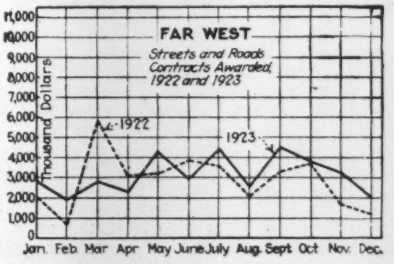












Yearly totals, monthly averages and actual volume are as follows:

Year	Value Total	Value Monthly Average	Actual Volume
1913	$48,471,000	$4,039,250	100
1918	73,793,513	6,149,459	81
1919	225,654,995	18,864,584	235
1920	265,423,491	22,118,624	218
1921	315,351,427	25,445,952	311
1922	334,694,000	27,891,116	397
1923	361,837,000	30,153,083	349

The situation in the various geographic sections for the last two years is covered by the following data:

	1922 No.	1922 Value	1923 No.	1923 Value
New England	80	$10,573,000	70	$9,691,000
Middle Atlantic	434	72,961,000	334	61,323,000
Southern	294	73,944,000	322	76,118,000
Middle West	490	76,136,000	480	83,810,000
West of Miss.	623	63,614,000	757	89,717,000
Far West	346	37,466,000	388	41,178,000
Total	2,267	$334,694,000	2,351	$361,837,000

The year 1924 already has to its credit $6,244,000 of awarded contracts. The proposed work not yet to the stage when bids are asked totals $24,180,000 of which $7,804,463 consist of bonds which have been voted and federal aid.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for, in Construction News, pp. 13 to 27, are the following:

Mining equipment, Duluth, Minn., Oliver Iron Mining Co., $770,000.

Office, Huntington, W. Va., Coal Exchange Bldg. Co., $1,000,000.

Institute, New York, N. Y., National Bible Institute, $1,500,000.

Portland cement, Springfield, Ill., Dept. of Pub. Wks., 4,000,000 bbl. cement.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 13 to 27, are the following:

Apartment, New York, N. Y., F. S. Paterno by day labor, $1,500,000.

School of Hygiene, Baltimore, Md., to M. A. Long Co., $1,000,000.

Apartment, Long Beach, Calif., to A. T. Hesse, Los Angeles, $1,000,000.

Store, Minneapolis, Minn., to Pike and Cook, first unit of $1,750,000.

Apartment, New York, N. Y., by day labor, One thousand fifty-eight 5th Ave., Inc., $2,000,000.

Apartment, New York, N. Y., M. Silverman by day labor, $2,000,000.

Two Billion Ft. of Lumber Used in Automobile Construction

Approximately two billion feet of lumber were consumed last year by the automobile industry of the United States in its various departments, according to the Southern Pine Association.

It was stated in a trade extension report made earlier in the year that 2,750,000 automobiles would be produced

in 1923. This estimate, however, has been found to be considerably under the actual production, for up to December 1, the number of cars manufactured was greatly in excess of that quantity. It is now conservatively estimated that the production figures for 1923 will reach 3,400,000 cars, of this number, approximately 37 per cent being closed cars. In addition, the production of trucks will aggregate 400,000.

Approximately 800,000,000 feet of lumber were used in automobile body construction alone in 1923.

Exports Gain Principally in Manufactures Ready for Use

Total exports of crude and manufactured materials and foodstuffs, during the first ten months of 1923, reached a value of $3,341,335, according to the Department of Commerce. This shows a slight gain in exports, compared with total imports valued at $3,212,520.

Imports of crude materials for use in manufacturing amounted to $1,188,477, or 37 per cent of all imports, as against $860,348, the value of exports in the same class. Imports of manufactures for further use in manufacturing reach a value of $614,576 compared with $463,886 for exports in the same class.

While this country imported more than it exported in the two classes mentioned, manufactures ready for consumption, valued at $1,243,880, were shipped to foreign countries during the ten months period, against only $641,188 in imports in the same classification.

Total exports for 1923 will probably exceed imports by $300,000,000.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Jan. 3; the next, on Feb. 7.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.64	$4.00	$4.40	$3.30	$3.55	$4.20	$3.60	$3.85	$4.25
Structural rivets, 100 lb.	4.40	4.75	4.90	3.75	+4.00	5.30	5.00	4.05	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.54	3.50	3.38	3.20	3.45	3.85	3.65	4.25	4.00
Steel pipe, black, 2½ to 6 in. lap, discount	44%	40%	43%	47%	53–5%	36%—37	10@47	40%	35% 47.43
Cast-iron pipe, 6 in. and over, ton	61.60@63.60	54.75	61.00	—57.20@60.20	60.50	+67.00	57.00	62.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.42	2.84	2.61	2.90	2.25
Gravel, ¾ in., cu.yd.	2.00	1.75	2.38	2.00	1.85	1.90	2.15	1.25	1.50
Sand, cu.yd.	1.25	1.20	2.00	2.00	+1.25@1.50	1.00	1.50	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.75	1.90	2.83	2.00	2.00	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+60.00	37.00	54.75	55.50	—44.75@46.00	+.50@.56	38.00	30.00	42.00
Lime, finishing, hydrated, ton	18.20	23.00	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.50	1.85	1.50	1.50	2.70	2.10	2.80	9.50
Common brick, delivered, 1,000	23.65	11.00	11.60	11.00	16@18	12.00	15.50	15.00	16.50
Hollow building tile, 4x12x12, per block	Not used	.10	.11	.0724	.075	.065	.....	.11	.115
Hollow partition tile 4x12x12, per block	.1179	.10	.11	.....	.....	.065	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	+.98	1.07	.94	1.01	1.10	1.03	1.15	1.38
Common Labor:									
Common labor, union, hour	.75	—.30	.....	.....	.....	.50@.55	.55	.62½	....
Common labor, non-union, hour	....	—.25	.30@.50	.82½	.40@.45	.35@.50	.50	.62½	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on white pine lumber, free on cars at mill. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 97.38). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in., $119.

Weekly Review of the Market

While business, generally, is a trifle slower than at the outset of 1923, the present condition is undoubtedly due to conservative buying or the maintenance of small reserve stocks of materials. Among the favorable factors, however, are: (1) Better tone to iron and steel markets; (2) Stability of materials prices; (3) Less speculation in the building market; (4) Continued employment of building labor throughout the winter, (5) Increased production in the automotive and textile industries; (6) Improvement in the agricultural situation; (7) Sound financial condition of the country; (8) Prospective tax reduction, and, (9) Another big construction year, provided prices do not rise much above present levels.

Few price changes in construction materials were reported from the nine cities listed each week in *Engineering News-Record*. Denver, however, reported an advance of $1 per ton in 6-in. c.-i. pipe and a stiff rise in fir timbers, due to seasonal closing of the mills. New York also reported an advance of $2 per M ft. in yellow pine timbers, during the week. A slight increase in the price of hollow tile was also quoted in Atlanta.

The iron and steel situation is briefly outlined as follows: Iron and steel scrap market active. Pig iron still apparently weak. Slight gains in buying of refined iron and cold drawn steel bars, also steel plates. Sheets and bars in good demand mostly for use in the automotive industry. Mild steel bars continue to be quoted at $2.40, with plates and shapes, $2.50 per 100 lb., Pittsburgh.